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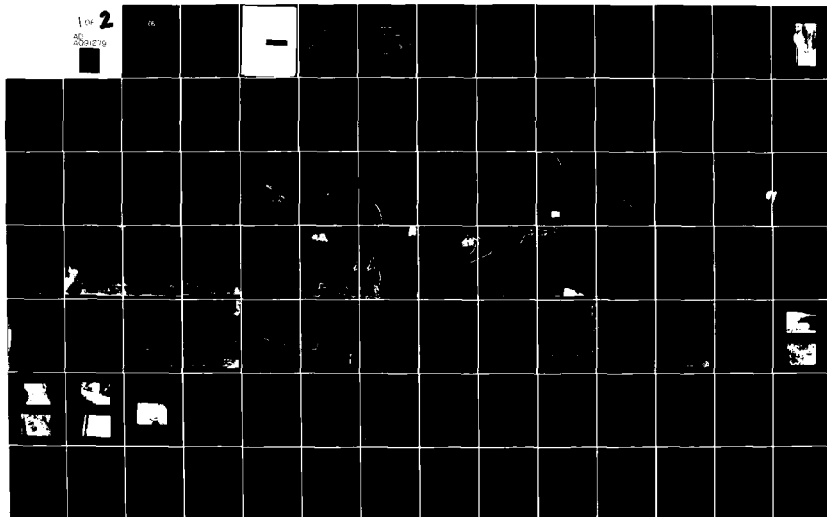
NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/13
NATIONAL DAM SAFETY PROGRAM. LAKE WELCH DAM (INVENTORY NUMBER N--ETC 11)
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization. Examination of the available documents and visual inspection of the Lake Welch Dam did not reveal conditions which constitute a hazard to human life or property.		

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Using the Corps of Engineers screening criteria for review of spillway adequacy, it has been determined that concrete gravity section of the dam would be overtopped for all storms exceeding approximately 12 percent of the Probable Maximum Flood (PMF). Although the spillway capacity is inadequate from a hydraulic and hydrologic point of view, the hydraulic inadequacy will not affect the safety of the dam because the concrete dam is supported on the sound rock and overtopping of the dam will cause neither significant erosion at the toe or abutment nor undermine the foundation of the dam. In addition, the stability of the concrete dam section is adequate during overtopping.

The following remedial and maintenance actions should be completed within one year.

- a. Establish a systematic program to observe changes of seepage occurring at the monoliths and the construction joints.
- b. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.
- c. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

In addition to above remedial and maintenance action the following should be considered:

- a. Resurface the downstream face to the original geometry.
- b. High level outlet made operable.

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~~Hudson River Basin~~

National Dam Safety Program

LAKE WELCH DAM

(Inventory Number NY283)

Hudson River

Basin **ROCKLAND COUNTY, NEW YORK.**

~~Inventory Number NY283~~

**PHASE I INSPECTION REPORT,
NATIONAL DAM SAFETY PROGRAM**

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C., 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

Accession No.	100
Project No.	
Investigator	
Distribution/Availability Codes	
Author and/or Special	A-82

NATIONAL DAM SAFETY PROGRAM
LAKE WELCH DAM
I.D. NO. N.Y. 283
D.E.C. #196-854
HUDSON RIVER BASIN
ROCKLAND COUNTY, NEW YORK
PHASE I INSPECTION REPORT

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Lake Welch Dam (I.D. No.N.Y. 283)
State Located: New York
County Located: Orange
Stream: Minisceongo Creek
Basin: Hudson River
Date of Inspection: April 24, 1980

ASSESSMENT

Examination of the available documents and visual inspection of the Lake Welch Dam did not reveal conditions which constitute a hazard to human life or property.

Using the Corps of Engineers screening criteria for review of spillway adequacy, it has been determined that concrete gravity section of the dam would be overtopped for all storms exceeding approximately 12 percent of the Probable Maximum Flood (PMF). Although the spillway capacity is inadequate from a hydraulic and hydrologic point of view, the hydraulic inadequacy will not affect the safety of the dam because the concrete dam is supported on the sound rock and overtopping of the dam will cause neither significant erosion at the toe or abutment nor undermine the foundation of the dam. In addition, the stability of the concrete dam section is adequate during overtopping.

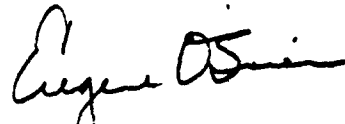
The following remedial and maintenance actions should be completed within one year.

- a. Establish a systematic program to observe changes of seepage occurring at the monoliths and the construction joints.
- b. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.

- c. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

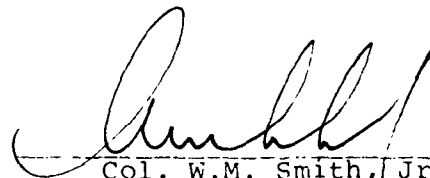
In addition to above remedial and maintenance action the following should be considered:

- a. Resurface the downstream face to the original geometry.
- b. High level outlet made operable.



Eugene O'Brien, P.E.
New York No. 29823

Approved by:



Col. W.M. Smith, Jr.
New York District Engineer

Date:

12 Sep 80



1. OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE WELCH DAM
I.D. NO. N.Y. 283
DEC #196-854
HUDSON RIVER BASIN
ROCKLAND COUNTY, NEW YORK

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Phase I inspection reported herein was authorized by the State of New York, Department of Environmental Conservation by a letter dated 7 January 1980, in fulfillment of the requirements of the National Dam Inspection, Public Law 92-367, 8 August 1972.

b. Purpose of Inspection

This inspection was conducted to evaluate the existing conditions of the dam, to identify deficiencies and hazardous conditions, to determine if these deficiencies constitute hazards to life and property, and to recommend remedial measures where required.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenant Structures

Lake Welch Dam, formerly known as Beaver Pond Dam is located on the east side of Lake Welch. The maximum height of dam is 32 feet. The dam is 788 feet long and consists of a concrete gravity section (563 feet) and an earth embankment (right of gravity section) with a central concrete core wall (225 feet). The concrete dam, supported on a rock foundation consists of 18 monoliths which are anchored to the rock by 25-ton post-tensioned rock anchors. According to available drawings the rock anchors are spaced along the crest 10 feet center to center and are embedded 10 feet into rock. (See drawings given in the Appendix A). The gravity section has a maximum height of 32 feet and a crest width of 3.5 feet. The upstream slope is vertical and downstream slope is 1.6V to 1H. The concrete includes a 152 foot-long spillway portion, the crest of which is one foot below the top of the dam.

The earth embankment at the left side of the concrete dam is about 10 feet wide at the crest and has a maximum height of 19 feet. The upstream slope is about 1V on 2.5H and covered with riprap. The downstream slope is 1V on 3H. A central corewall extends 2 feet from dam crest to the rock, and is about 1.6 feet wide at the top. The slope of the upstream face of the wall is vertical; the downstream face is battered downstream at 4V on 1H from the top of wall to a depth of about 6 feet, and vertical to the remainder of the depth.

There are two regulating outlet pipes located through the concrete dam. The high level outlet is a 12 inch diameter cast iron pipe which discharges water from a square concrete intake structure located at the upstream face of the concrete section, about 210 feet from the left abutment. Water discharges from the reservoir into the intake structure over two 3.3-foot long by 4-inch wide slot openings, located on two walls of the structure. The sill of the openings is at El. 1010, about 6 feet below the top of the concrete dam. Discharge through the pipe may be controlled by a gate valve which is operated from the top of the structure. According to available documents, the outlet once served as a service spillway maintaining the pool at El. 1010 during low flows.

The low level outlet is a 3-foot square sluiceway located through the concrete dam, about 180 feet from the left abutment. Discharge through the sluiceway is controlled by a manually operated sluice gate located at the upstream face of the dam, the control of which is located at the crest of the dam.

The two outlets and the spillway discharge into the natural channel of Minisceongo Creek.

b. Location

The dam is located within the Palisades Interstate Park, Harriman Section, about 2 miles west of the Town of Willow Grove, in Rockland County, New York.

c. Size Classification

The dam is 32 feet high, and has a lake storage capacity of 4,750 acre-feet (1,000 and to 50,000 acre-feet). Therefore, the dam is classified as "Intermediate".

d. Hazard Classification

The dam is in the high hazard potential category because a campsite, several homes along the creek and in the Town of Willow Grove, state Route 210 and the Palisades Interstate Parkway are all located within 1.5 miles downstream from the dam.

e. Ownership

Lake Welch Dam is owned, operated and maintained by the Palisades Interstate Park Commission of the New York State Department of Parks and Recreation, Administration Building, Bear Mountain, New York 10911, Tel. No. (914)786-2701.

f. Purpose of Dam

The impoundment provided by the dam is used mainly for recreation. This lake also supplies water via pipelines to campsites at the lake.

g. Design and Construction History

Original design and construction records are not available. It is reported the construction of the dam was completed in 1937. The designer of the original dam was Mr. W.A. Welch, Chief Engineer, Palisades Park Commission. The name of the Contractor is unknown. The concrete dam was rehabilitated in 1959 and 1979. Because of leakage the entire concrete dam was resurfaced in 1959 by applying a 3-inch "gunite" layer. In 1979, the concrete dam was again repaired because of leakage problems; in addition, the stability of the dam was improved. According to available documents, the entire concrete dam was strengthened by installing post-tensioned rock anchors from the crest of dam into the foundation. The post-tensioned rock anchors were installed and grouted in drill holes spaced at 10 feet center to center along the crest. Additional holes were drilled through the dam from the crest and pressure grouted. The design and supervision of the repairs were carried out by the engineering firm of Charles T. Main, Boston. In addition, the existing gunite surface of the downstream face was partially removed and the original concrete exposed in preparation for resurfacing later this year.

h. Normal Operating Procedure

The USGS map and available drawings show that the normal pool level once was maintained at El 1010, the level of the sill at the high level regulating outlet. Since the high level outlet pipe is now inoperative and the gate in the closed position, the lake level is maintained at the crest of the ungated principal spillway, El. 1015, about 1.3 feet below the top of the concrete dam.

1.3

PERTINENT DATA

- a. Drainage Area (sq.miles) 2.87
- b. Discharge at Damsite (cfs)
- | | |
|-------------------------|-------------|
| Principal spillway, | |
| Top of dam (El. 1016.3) | 591 |
| Sluiceway, | |
| Top of dam (El. 1016.3) | 250 |
| 12-inch CI outlet pipe | Inoperative |
- c. Elevation (feet above MSL)
- | | |
|---------------------------|--------|
| Top of dam (concrete dam) | 1016.3 |
| Top of dam (earth dam) | 1019.0 |
| Principal spillway crest | 1015.0 |
| Sluiceway invert | 984 |
- d. Reservoir
- | | |
|-------------------------------|-----|
| Length of normal pool (miles) | 0.6 |
| Surface area (acres) | 218 |
- e. Storage (acre-feet)
- | | |
|---------------------------------|------|
| Top of principal spillway crest | 4450 |
| Top of dam | 4750 |
- f. Dam
- Type: concrete gravity and earth
embankment
- Length (ft): concrete-563; embankment-225
- Height (ft): concrete- 32; embankment- 19
- Crest width (ft); concrete-3.6;embankment-10
- Side Slopes: upstream - concrete-vertical;
embankment-1V on 3H
downstream - concrete-1.6V on 1H
embankment-1V on 2.5H
- Impervious core: embankment - concrete wall
- Concrete wall (top width - ft): embankment-1.5 ft
- Side slopes: upstream - vertical
downstream-4V on 1H (up to 6.0 ft
from top of wall and
vertical to rock
foundation)
- g. Spillway
- Type: Broad-crested, concrete
- Length (ft): 152
- Crest Elevation (ft):1015.0

h. Regulating Outlets

Type: High level - 12-inch diameter
CI pipe
Low level - 3 foot square
concrete sluiceway
Elevation (ft): (High level)-intake - 1010
outlet - 984
(Low level) -intake - 991.5
outlet - 984-

SECTION 2 - ENGINEERING DATA

2.1 GEOLOGY

Lake Welch Dam is located in the New England Upland physiographic province of New York State. These uplands, with relief ranging from 500 to 1,300 feet above sea level, trend northeast-southwest; folds striking northeasterly and plunging slightly to the north are characteristic of the province. Fault lines throughout the New England uplands are generally parallel to the strike of the rocks. Bedrock in the vicinity of Lake Welch includes crystalline metasedimentary hornblende gneisses and leucogranitic gneisses of Precambrian Age.

2.2 SUBSURFACE INVESTIGATION

No subsurface investigation could be located for the project. However, the "General Soil Map of New York State" prepared by the Cornell University Experiment Station (1963) indicates that the surficial soils around Lake Welch Dam are of the Rockland-Chatfield Association. The Rockland, about 70% of the area, is steep slopes, gneiss rock outcrop with shallow, stony soil developed from glacial till. The remaining area is predominantly Chatfield soils that are moderately deep (less than 30 inches to bedrock), very stony and well drained, developed from glacial till derived from gneiss.

2.3 DESIGN RECORDS

The original dam was designed by Mr. W. A. Welch, Chief Engineer of the Palisades Interstate Park Commission. The dam is reported built in 1937. There are no design data or specific design memoranda available for the project features. Two contract drawings dated February 1928 were obtained from the New York State Department of Environmental Conservation and are given in Appendix A. The drawings show the plan, profile and details of the dam.

The concrete dam was resurfaced in 1959 by applying a 3 inch thick gunite surface. The details of modifications are shown on a drawing entitled "Details of Dam Repairs" dated July 17, 1958, prepared by the Palisades Interstate Park Commission and given in Appendix A.

Because of excessive seepage at the concrete dam, major modifications were made in 1979 in accordance with recommendations by Charles T. Main, Consulting Engineers, Boston, Massachusetts. The recommendations included chemical and cement grouting to control seepage through horizontal and construction joints and strengthening of the dam by installing rock anchors. The details of the modifications, shown on a construction drawing entitled "Lake Welch Dam Repairs", dated April 4, 1978 and prepared by Charles T. Main, Inc., Boston, Massachusetts, are given in the Appendix A.

2.4 CONSTRUCTION RECORDS

No detailed construction records of the original dam and the subsequent modifications are available; however, photographs and daily narratives of the 1979 repairs are available.

2.5 OPERATION RECORDS

There is no formal operation and maintenance manual for the project. There are no records of rainfall and operation of the gates and the sluiceways.

2.6 EVALUATION OF DATA

Existing information was made available by the New York State Department of Environmental Conservation, Albany, New York, and the owner.

The information obtained from the available data, the personal interviews and the visual inspection are considered adequate for the Phase I inspection and evaluation. Reviews of the original and subsequent drawings indicate some discrepancies, as follow:

- a. Crest elevation of the concrete dam is incorrectly shown on 1978 repair drawings.
- b. The length of spillway shown on the original drawing shows about 89.5 feet, whereas repair drawings of 1978 show about 152 feet. There are no construction records of the spillway modifications available; however, the spillway length of 152 feet was confirmed during the inspection.
- c. Geometry of the downstream face of the dam is in accordance with 1978 repair drawings and not as shown on the 1929 drawings.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

The visual inspection of the Lake Welch Dam was made on 24 April 1980. The weather was sunny with the temperature at about 60°F. The reservoir level was El.1015.4 at the time of inspection, about 3 inches above spillway crest.

b. Dam

(i) The Gravity Section Including Spillway:

The concrete gravity section appears to be in generally good condition. The horizontal and vertical alignment are uniform and there is no indication of movement. The crest and the upstream face above the waterline appears to be in good condition. At the crest there are grouted holes which were drilled during the recent repairs.

The gunite surface at the downstream face of the dam has been removed and the original concrete exposed. The exposed concrete surface appears in good condition. There is minor seepage through several construction and monolith joints. Several construction joints are packed with oakum to prevent seepage.

(ii) Embankment: The earth embankment appears to be in generally good condition. The horizontal and vertical alignment of the crest are uniform.

The downstream slope does not exhibit any evidence of subsidence, erosion and sloughing. The slope is covered with ground cover, seedlings, shrubs and trees. There are no signs of seepage at the slope, toe and downstream from the toe. There is heavy vegetation, including large trees, downstream of the toe area.

The upstream slope does not show any sloughing or erosion. The slope is covered with ground cover and shrubs and trees.

c. Appurtenant Structure

The concrete surface of the low level sluiceway is in good condition. The physical condition of the downstream face of the sluice gate appears in good condition except for minor rusting. Although the gate is closed there is minor discharge emerging from the sluiceway. The operating control for the gates located at the crest appears to be in good condition. The gate was not operated during the inspection because

the owner's representative did not have the keys for a padlock; the owner reports that the gate is in operating condition.

The 12-inch cast iron outlet pipe is closed and reported to be inoperable. However, there was discharge of about 1 cfs through the pipe.

d. Downstream Channel

The channel downstream of the concrete dam is Minisceongo Creek. In the vicinity of the dam, the channel floor and the side slopes are in rock. There is some vegetation including bushes and large trees, which will not impede flows over the spillway.

e. Reservoir Area

In the vicinity upstream of the dam there was no evidence of sloughing, potentially unstable slopes, or other unusual conditions which would adversely affect the dam.

3.2 EVALUATION OF OBSERVATIONS

Visual observation made during the course of the investigation revealed several deficiencies which at present do not adversely affect the adequacy of the dam. However, these deficiencies do require attention and should be corrected.

The following is a summary of the problem areas encountered, in order of importance, with the appropriate recommended action:

1. Establish a systematic program to observe and monitor changes in seepage occurring at the monoliths and construction joints.
2. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.
3. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

In addition to above remedial and maintenance the following should be considered:

- a. Resurface the downstream face to the original geometry.
- b. High level outlet made operable.

SECTION 4 - OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

There is no specified required release of water from the lake. The lake level is maintained at the principal spillway crest level the entire year. The low level outlet which is a 3-foot square sluiceway, is usually kept closed. The 12-inch diameter cast iron pipe is closed and reported inoperative.

4.2 MAINTENANCE OF THE DAM

The dam is maintained by the owner, Palisades Interstate Park Commission. Maintenance of the dam is considered inadequate as evidenced by the seepage through the monolith joints; at the concrete section there is extensive vegetative growth on the earth embankment and an inoperable regulation gate at the high level outlet.

4.3 WARNING SYSTEM IN EFFECT

There is no warning system in effect or in preparation.

4.4 EVALUATION

The dam and appurtenances have not been maintained in satisfactory condition as noted in Section 3: Visual Inspection.

SECTION 5 - HYDROLOGIC/HYDRAULIC

5.1 DRAINAGE BASIN CHARACTERISTICS

Lake Wlech Dam is located about 2 miles west of Willow Grove in Rockland County, New York. The total drainage area contributing to the lake is 2.87 square miles of which the lake occupies 234 acres or 13% of the area. The basin is a part of the Palisades Interstate Park and is mainly undeveloped except for a few campsites. Relief in the drainage area is fairly steep, varying from E. 1015 (lake surface) to ridges above El 1200.

5.2 ANALYSIS OF CRITERIA

The analysis of Lake Welch Dam was performed using the U.S. Army Corps of Engineers HEC-1 computer program 1/. The Probable Maximum Precipitation (PMP) was obtained from Hydro-meteorological Report No. 51 4/. The unit hydrograph was computed using the Snyder method 6/ and average regional coefficients were 2 and 400 for C_t and C_p , respectively. It was assumed that there would be an initial rainfall loss of 2 inches and that the constant loss rate would be 0.5 inches per hour. It was also assumed that both outlets were closed during the flood event. In accordance with the recommended guidelines of the Corps of Engineers 7/, the adequacy of the spillway was analyzed using the Probable Maximum Flood (PMF) and one-half the PMF.

5.3 SPILLWAY CAPACITY

The principal spillway is located at the concrete dam. The length of spillway is about 152 feet with a 3.5-foot wide concrete sill at El 1015. The maximum discharge capacity of the principal spillway is 591 cfs.

5.4 RESERVOIR CAPACITY

Normal capacity of Lake Welch at El 1010 (equivalent to the intake elevation of high level outlet) is reported to be about 3440 acre-feet 7/. The computed storage between El 1010 and El 1015 (principal spillway crest) is about 1010 acre-feet. Total reservoir capacity to the top of the concrete dam (El 1016.3) is about 4750 acre-feet. The available surcharge storage between the spillway crest and the top of the dam is about 291 acre-feet which is equivalent to about 1.9 inches of runoff over the entire basin.

5.5 FLOODS OF RECORD

There are no available records of floods or maximum lake elevations.

5.6 OVERTOPPING POTENTIAL

The potential of the dam being overtopped was investigated on the basis of the spillway discharge capacity and the available surcharge storage to meet the selected design flood inflows.

The Probable Maximum Flood routed through the lake caused the lake surface to rise to El 1018.41, 2.11 feet above the concrete dam, but does not overtop the embankment (El 1019.0). The one-half Probable Maximum Flood routed through the lake caused the lake surface to rise to El 1017.41, 1.11 feet above the concrete dam. The peak outflow discharge was 4765 cfs.

Using the Corps of Engineers criteria, the maximum spillway capacity without overtopping the dam is 12% of PMF outflow.

5.7 EVALUATION

The dam does not have sufficient spillway capacity to pass either the PMF or one-half the PMF without overtopping the dam. On the basis of this investigation the project discharge capacity is considered to be inadequate from a hydrologic and hydraulic point of view; however, overtopping of the dam under the PMF would cause neither significant erosion at the toe or abutment nor undermine the foundation of the dam.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Visual observations did not indicate condition which would adversely affect the structural stability of the dam. The observed seepage through the monolith and construction joints of the concrete dam are not detrimental to the dam's stability or safety at the present time.

b. Design and Construction Data

The original preconstruction design computations regarding the structural stability of the dam or spillway are not available. Stability analysis of the concrete dam with the rock anchors was carried out by Charles T. Main, Inc., Consulting Engineers, Boston, Massachusetts, for the 1979 rehabilitation program; these are given in the Appendix F.

c. Operating Records

There are no available records of reservoir elevation and gate operation. No major operational problems which would affect the stability of the dam were reported.

d. Post Construction Changes

The concrete dam was resurfaced in 1959 by applying a 3 inch thick gunite surface. The details of modifications are shown on a drawing entitled "Details of Dam Repairs" dated July 17, 1958, prepared by the Palisades Interstate Park Commission and given in Appendix A.

Because of excessive seepage the concrete dam, major modifications were made in 1979 in accordance with recommendations by Charles T. Main, Consulting Engineers, Boston, Massachusetts. The recommendations included chemical and cement grouting to control seepage through horizontal and construction joints and strengthening of the dam by installing rock anchors. The details of the modifications, shown on a construction drawing entitled "Lake Welch Dam Repairs", dated April 4, 1978 and prepared by Charles T. Main, Inc., Boston, Massachusetts, are given in the Appendix A.

e. Seismic Stability

According to the recommended Corps guidelines, the dam is located in Seismic Zone No.1. However, based on past earthquake history, the New York State Geological Survey

considers the site to be in Zone 2. Based on this assessment the dam is considered in the Seismic Zone 2. The results of Seismic Stability are described in Section 6.2.

6.2 STRUCTURAL STABILITY ANALYSIS

The available structural stability analysis of the non-overflow section of the concrete dam was reviewed. The method of analysis and stability criteria, except the values of sliding coefficients, were computed in accordance with EM 1110-2-2200 published by the Corps of Engineers, U.S. Army. The sliding coefficient values used were higher than recommended. The spacing of rock anchors used in the structural stability analysis is not the same as that shown on 1978 construction drawings. The analysis shows that rock anchors at the gravity section are spaced 5 feet center to center, whereas the 1978 drawings show a 10-foot spacing. The owner was unable to verify the discrepancy. Since a 10-foot spacing of the rockbolts at the gravity section would be more critical, additional analyses of structural stability using this anchor spacing were performed. These are included in the Appendix E, and summarized as follows:

<u>Loading Condition</u>	<u>Location of Resultant</u>	<u>Sliding F.S. (see Appendix E)</u>
a. Normal loading condition, reservoir level at spillway crest, no ice load	Within middle third	1.53
b. Normal loading condition, reservoir level at spillway crest, with ice load	-3.09 feet outside middle third	1.30
c. Unusual loading: flood level equal to 1/2 PMF at gravity section	Within middle half	1.17
d. Extreme loading: flood level equal to PMF at the gravity section	Within middle half	1.06
e. Unusual loading: reservoir level at spillway crest, and earthquake forces	Within the middle half	1.30

The results of the stability analysis indicate that stability of the gravity section of the dam against overturning is inadequate for all loading conditions except normal loading.

The analysis indicates that in order for the resultant of the force to be within the middle third under the other loading cases, the rock bolts would have to be stressed 30.5 tons, which is above the working load (25 tons) and less than the ultimate limit (37 tons). Because of the additional force (5.5 tons) that can be developed in the anchors, the stability of the gravity section of the dam against overturning is considered adequate. The sliding stability is considered adequate for all cases.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Examination of available documents and the visual inspection of the Lake Welch Dam and appurtenant structures did not reveal any conditions which constitute a hazard to human or property. The dam (earth and concrete gravity sections) are not considered to be unsafe.

Using the Corps of Engineers screening criteria for review of spillway adequacy, it has been determined that the concrete gravity dam would be overtopped for all storms exceeding approximately 12 percent of the PMF. Although the spillway capacity is inadequate from a hydraulic and hydrologic point of view, the hydraulic inadequacy will not affect the safety of the dam because the concrete dam is supported on sound rock and overtopping of the dam will cause neither significant erosion at the toe or abutment, nor undermine the foundation of the dam. In addition, the concrete dam is stable under all loading conditions.

b. Adequacy of Information

The information and data available were adequate for performance of this investigation.

c. Necessity of Additional Investigations

No additional investigations are required.

d. Urgency

The recommended measures 1 through 3 as described below must be corrected within 1 year from notification.

7.2 RECOMMENDED MEASURES

The following are the recommended measures:

1. Establish a systematic program to observe and monitor changes in seepage occurring at the monoliths and construction joints.
2. Remove all trees and brush growth on the slopes of the embankment. Provide a program of periodic cutting and mowing of the embankment surfaces.

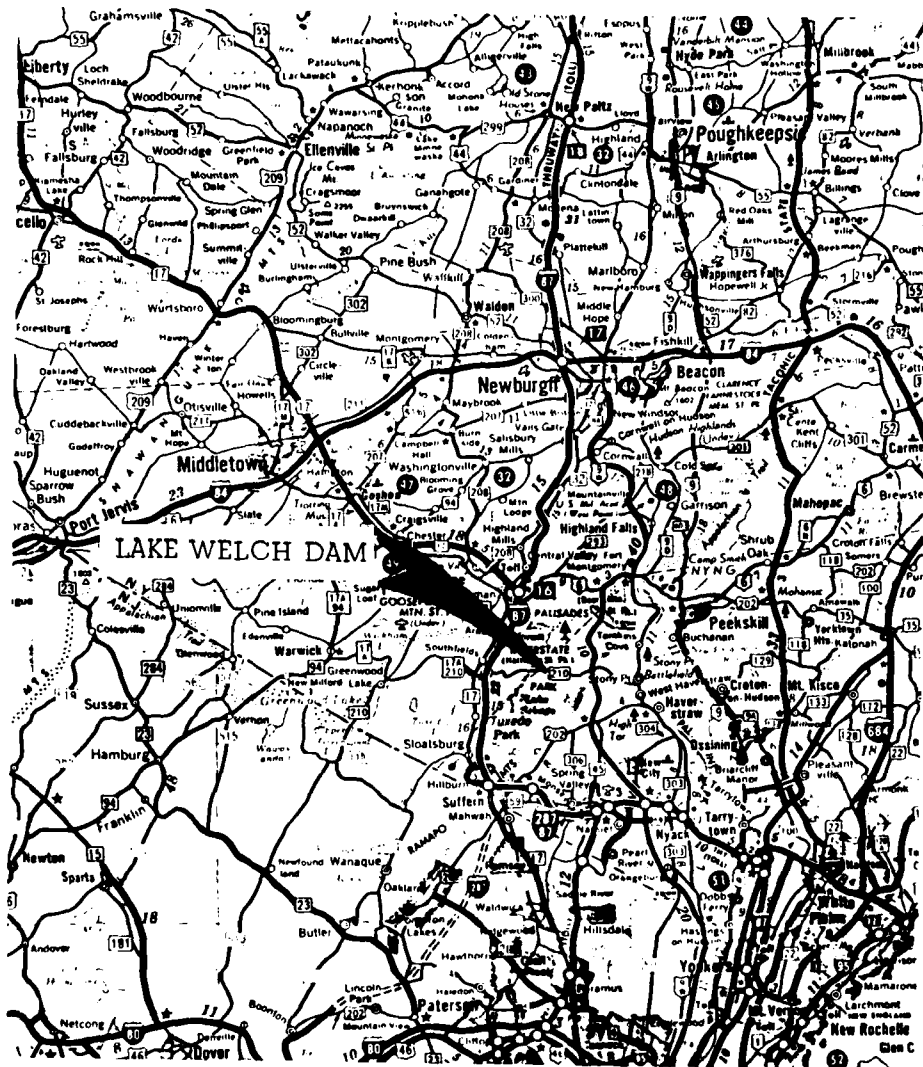
3. Provide a program of periodic inspection and maintenance of the dam and appurtenances including yearly operation and lubrication of the reservoir drain. Document this information for future references. Also develop an emergency action plan.

In addition to above remedial and maintenance, the following should be considered:

- a. Resurface the downstream face to the original geometry.
- b. High level outlet made operable.

DRAWINGS

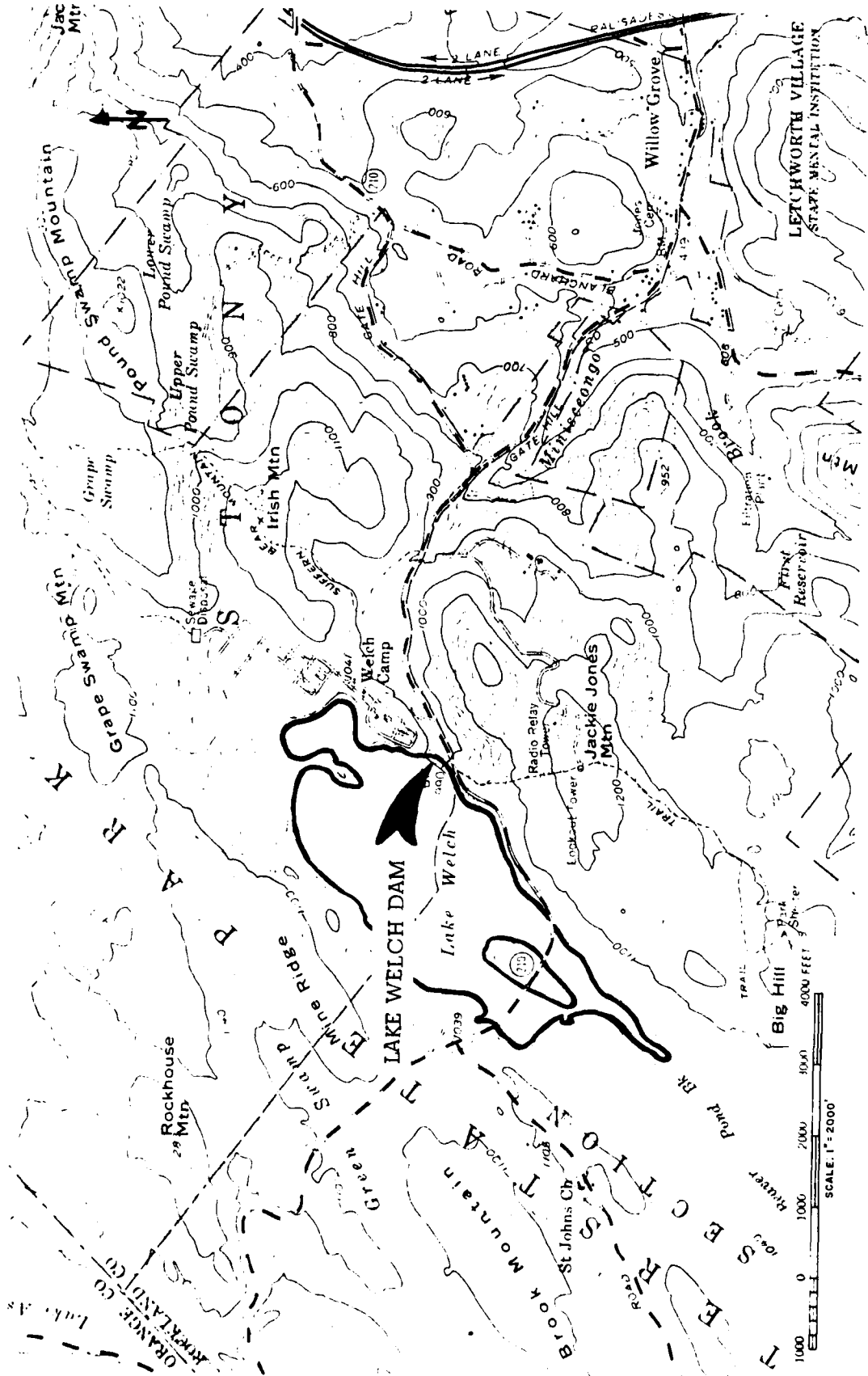
APPENDIX A



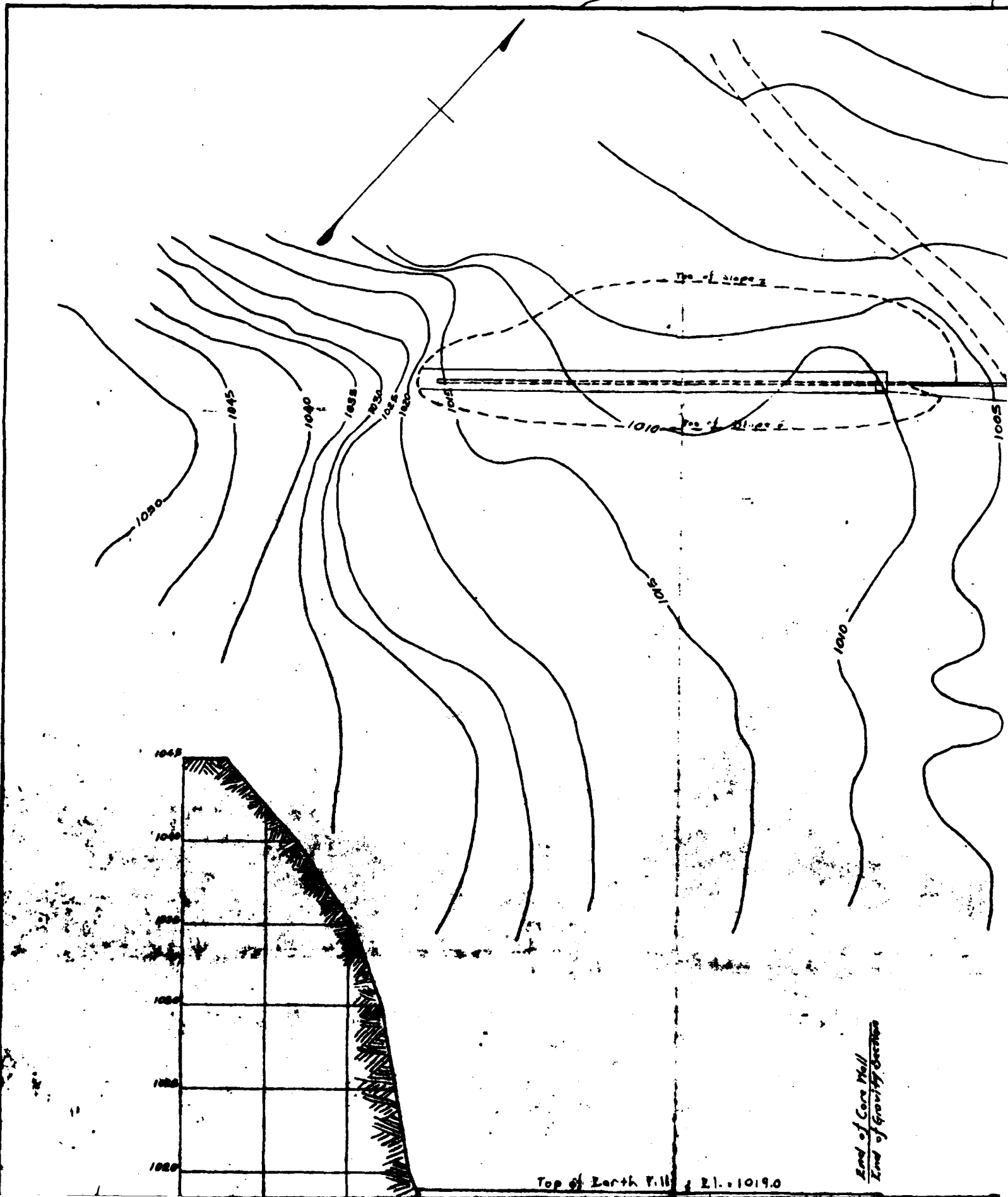
SCALE 1 inch = 11.2 Miles

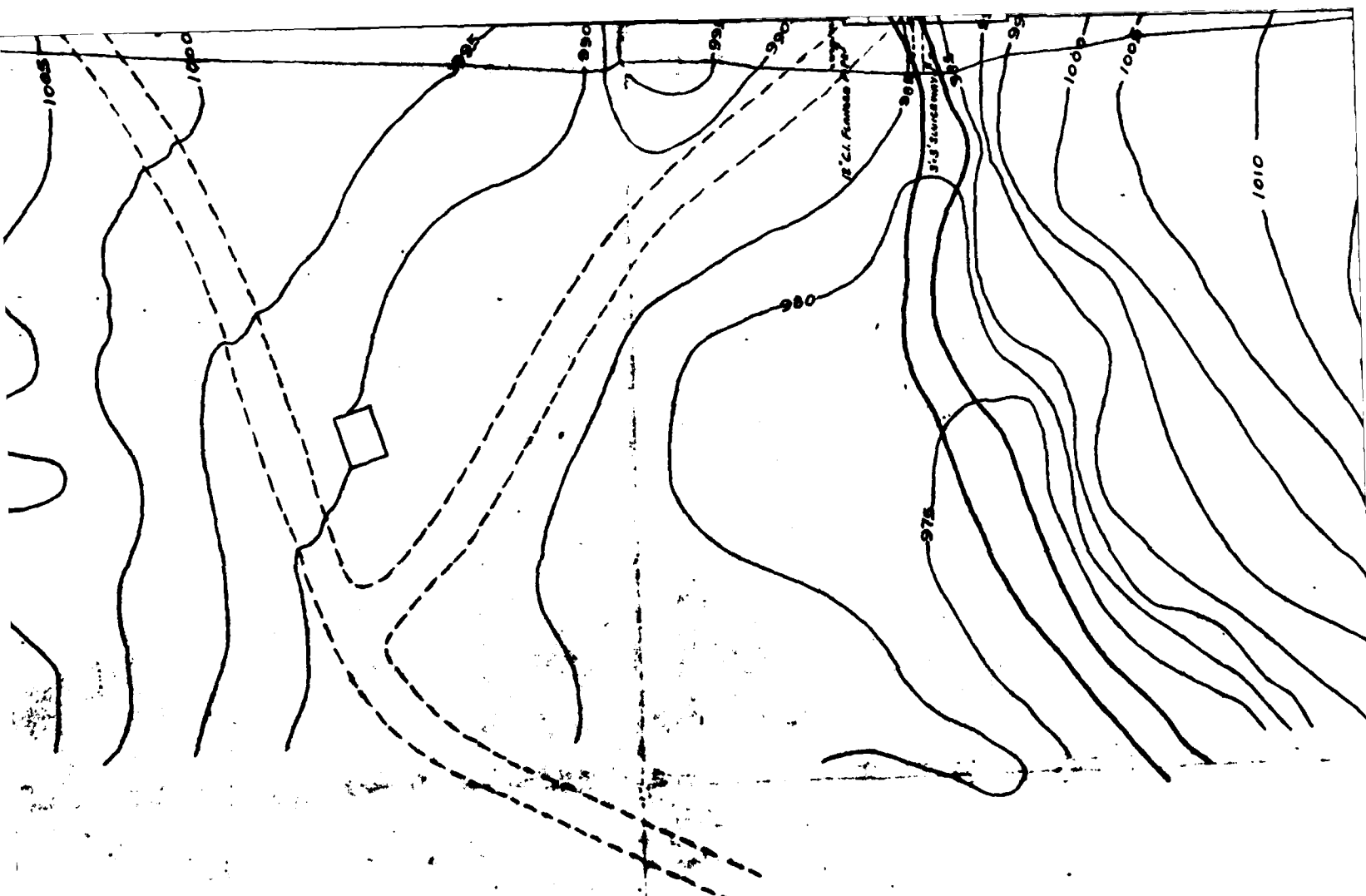
VICINITY MAP
LAKE WELCH DAM

THIELLS QUADRANGLE
NEW YORK



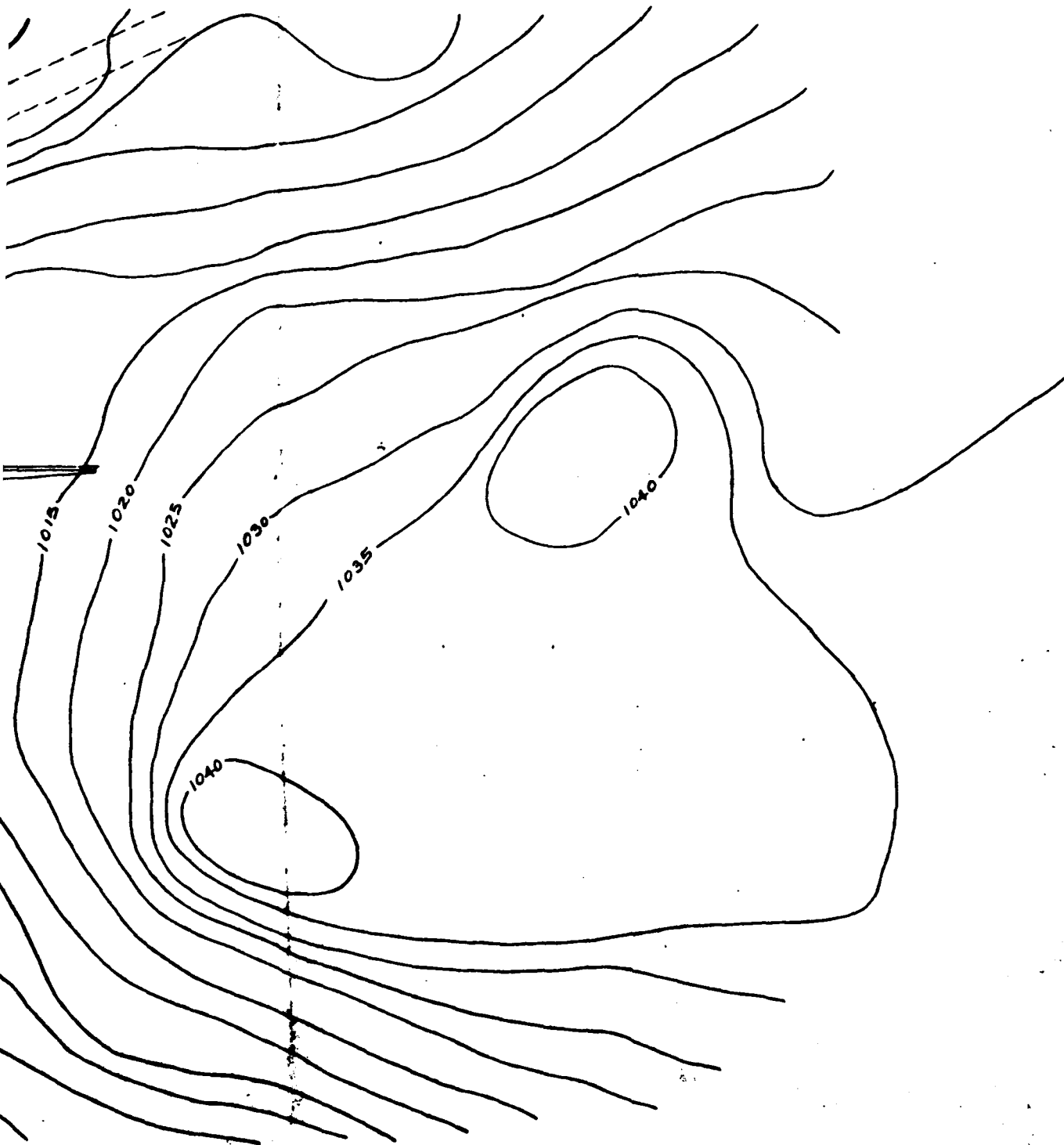
TOPOGRAPHIC MAP
LAKE WELCH DAM





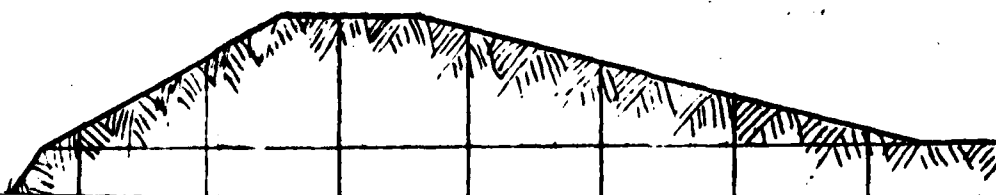
PLAN

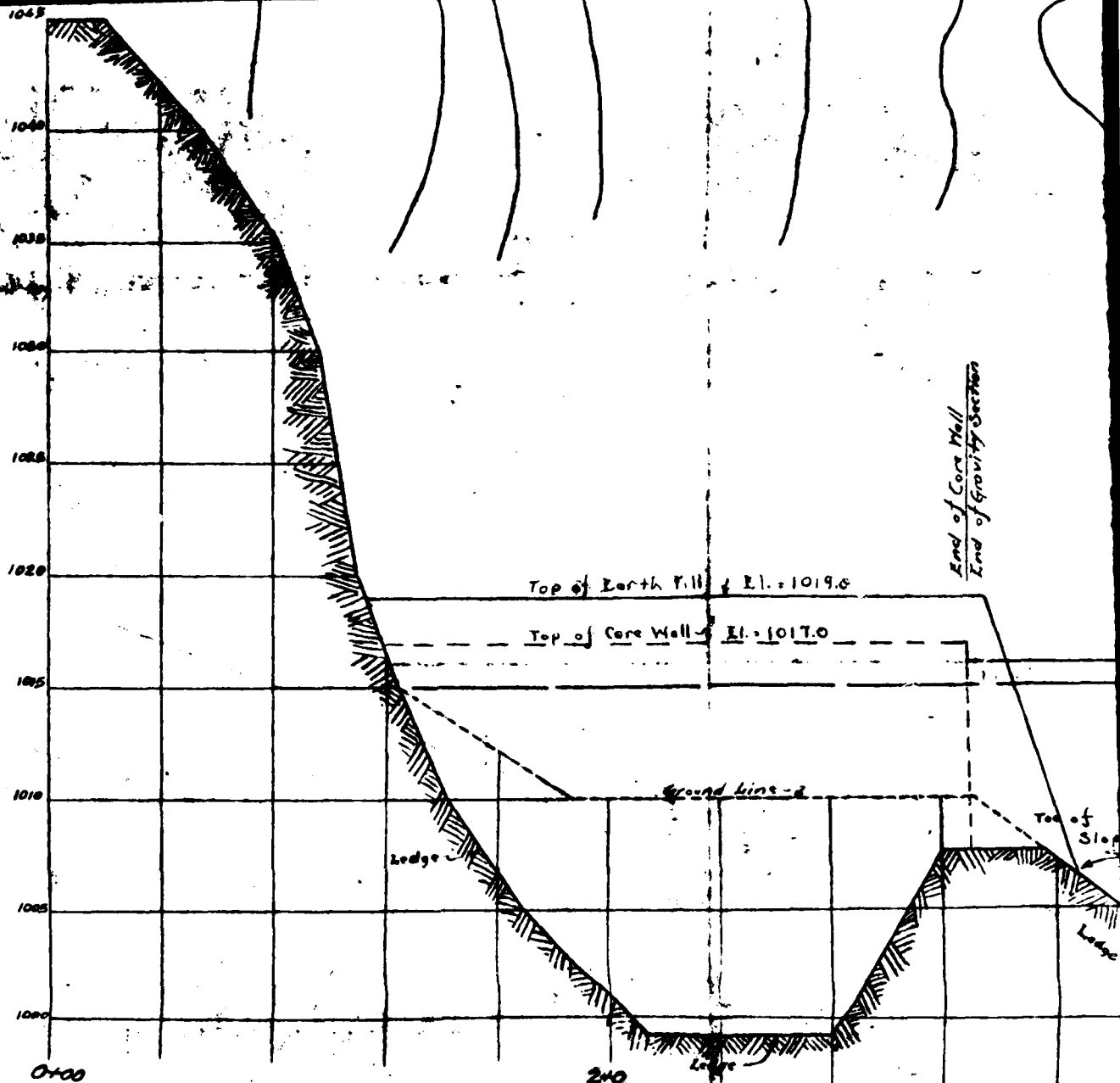
3



Note:

Expansion joints to be
placed every 30'





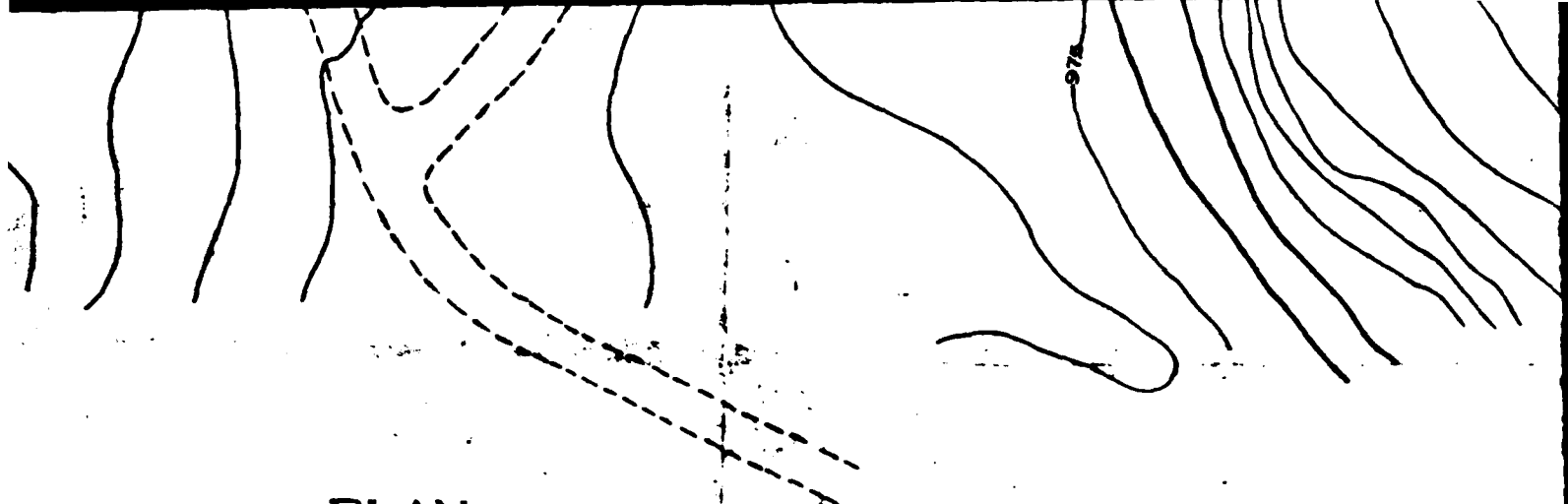
U.S. DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
STATE PARK EMERGENCY CONSERVATION WORK
NEW YORK STATE PARK NO 26
PALISADES INTERSTATE PARK
TOWN OF STONY POINT ROCKLAND COUNTY NEW YORK

BEAVER POND DAM

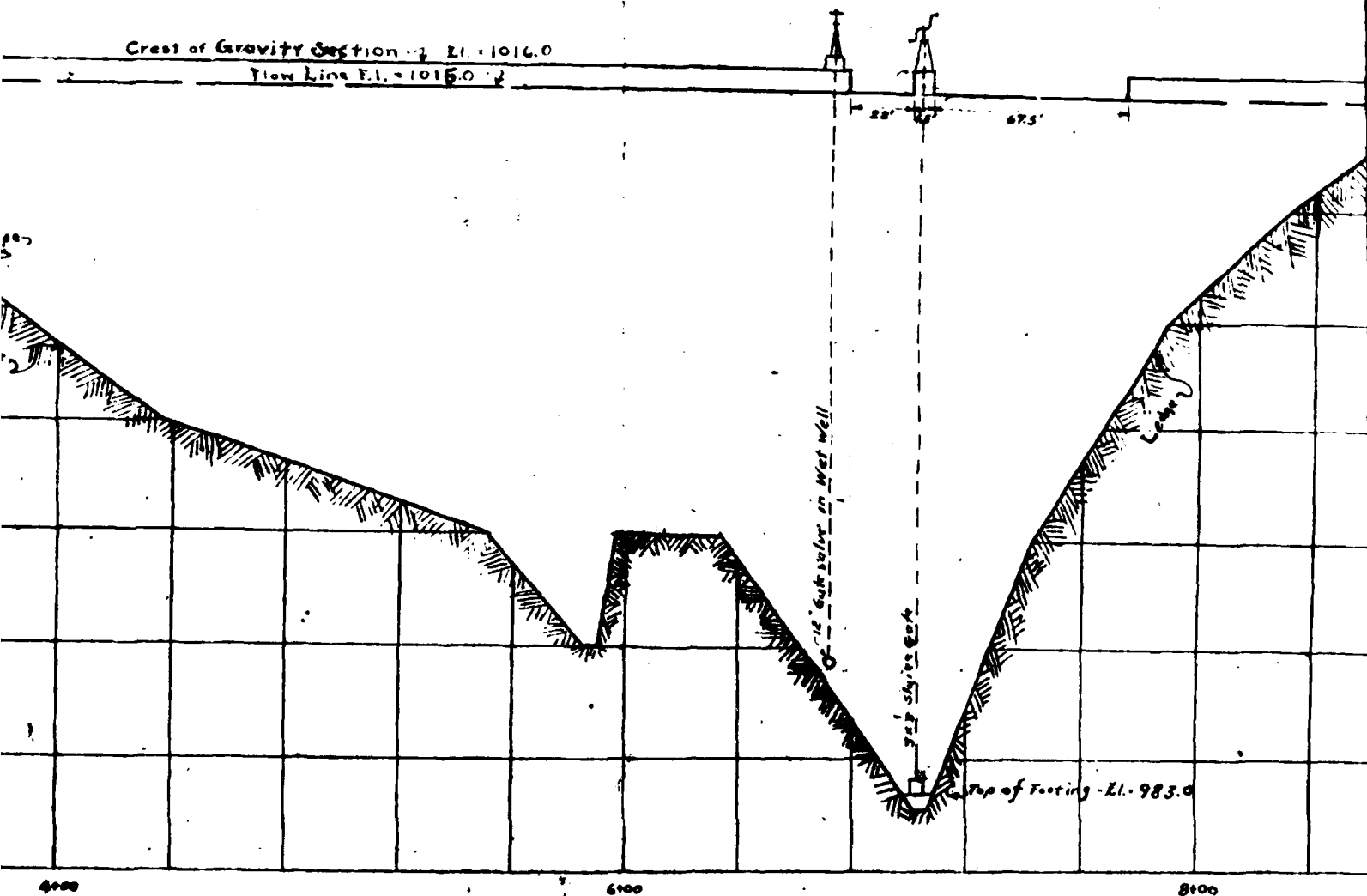
SCALES AS SHOWN DECEMBER 1, 1933 PREPARED BY

Recommended for Approval: [Redacted] General Superintendent.
Approved By: [Redacted] Chief Engr. and Gen'l. Mgr.
Approved By: [Redacted] District Inspector E.C.W.
Approved By: [Redacted] District Officer E.C.W.

4



PLAN

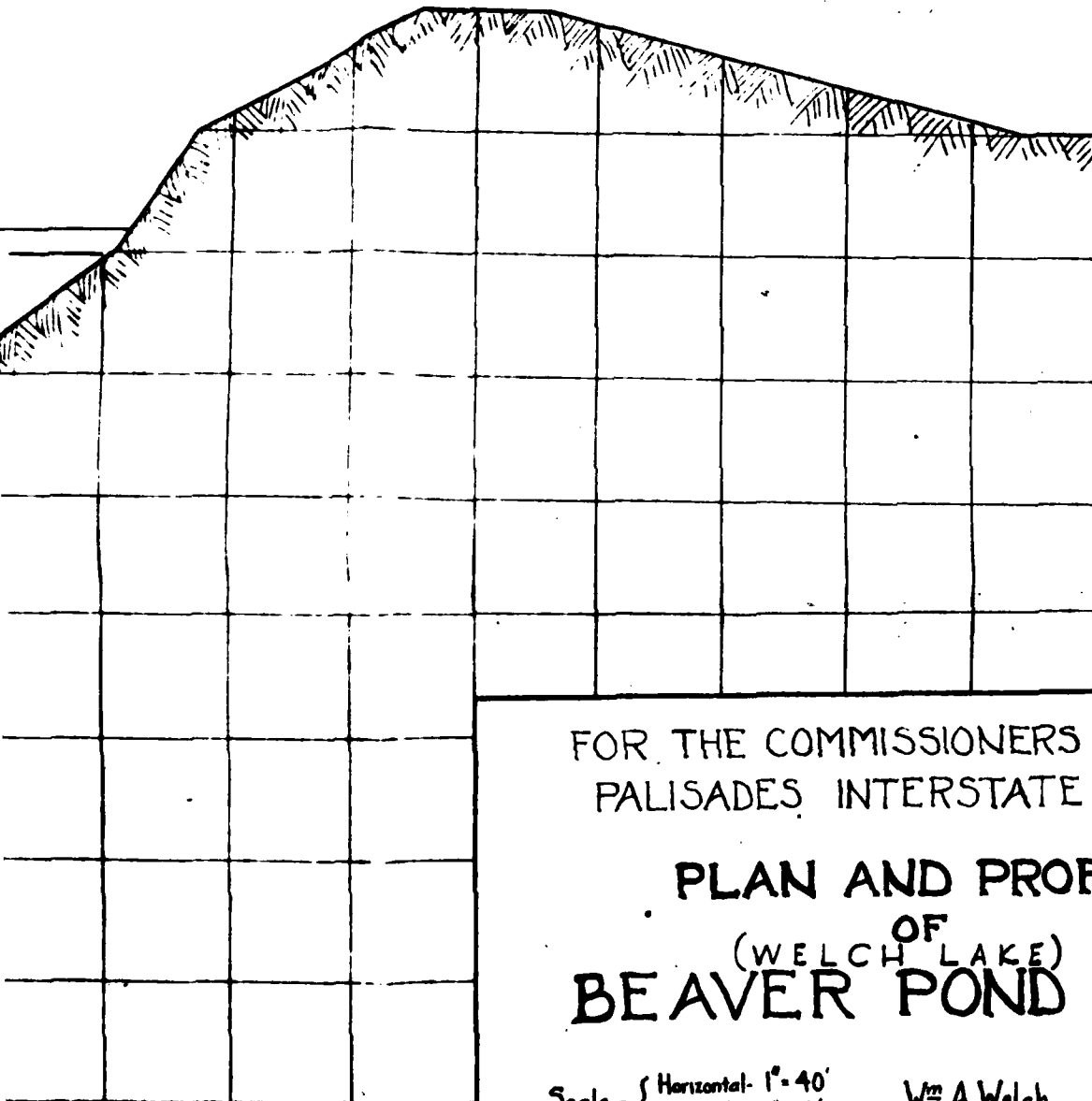


PROFILE

5

Note:

Expansion joints to be
placed every 30'



FOR THE COMMISSIONERS OF THE
PALISADES INTERSTATE PARK

PLAN AND PROFILE
OF
(WELCH LAKE)
BEAVER POND DAM

Scale - { Horizontal - 1" = 40'
Vertical - 1" = 5'
June 1929
Revised Aug. 1929

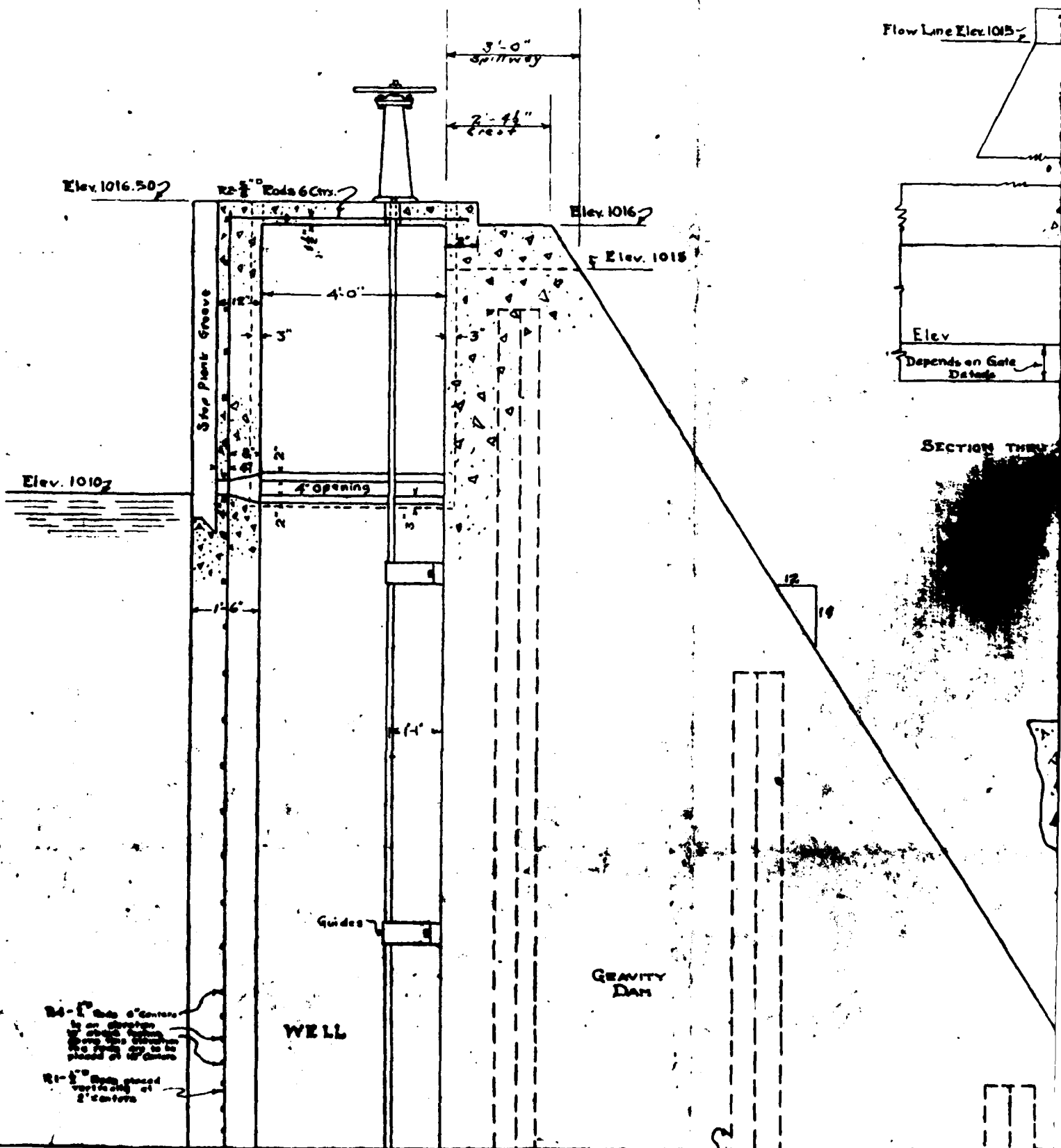
Wm A. Welch
Chief Engineer

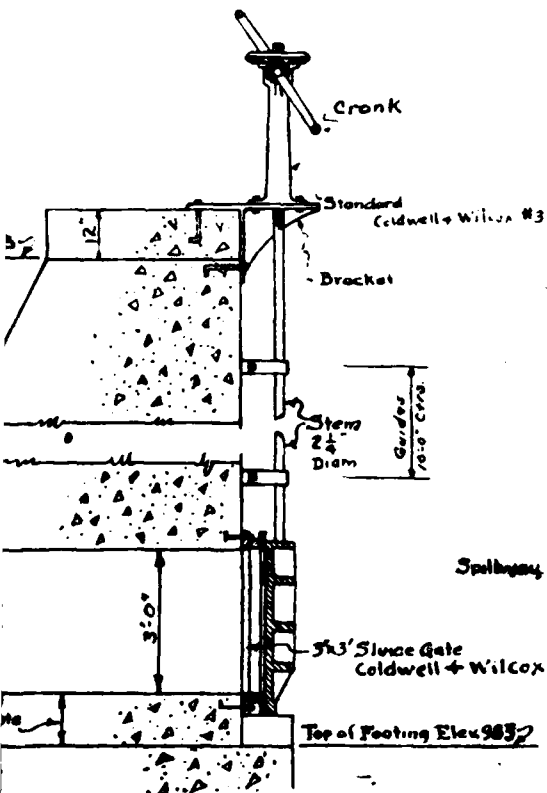
1/2 No 858-A
P5-F8

6

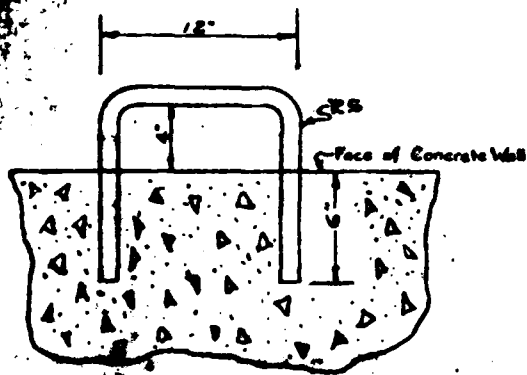
Revised print received 10/22/68

1

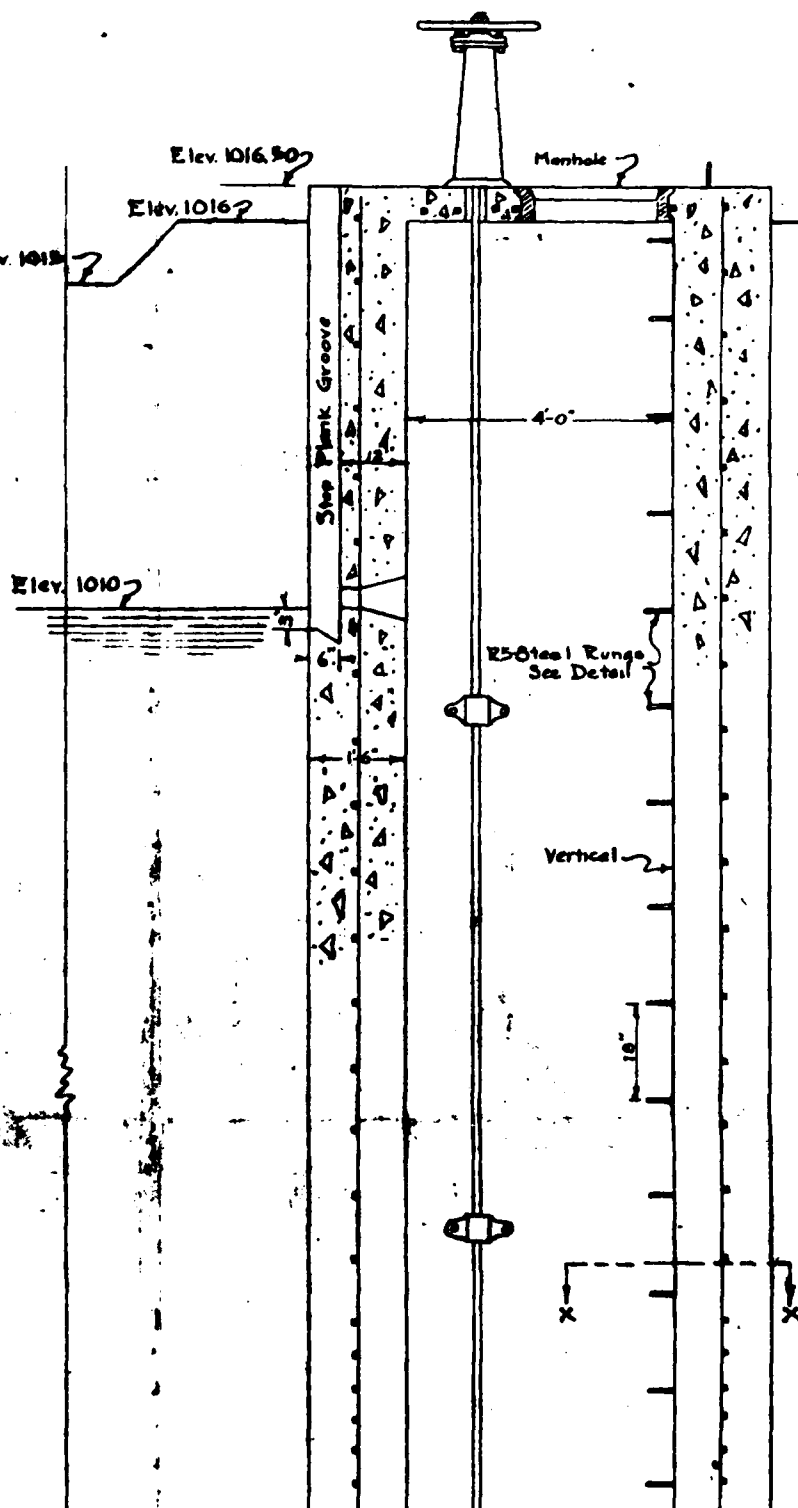


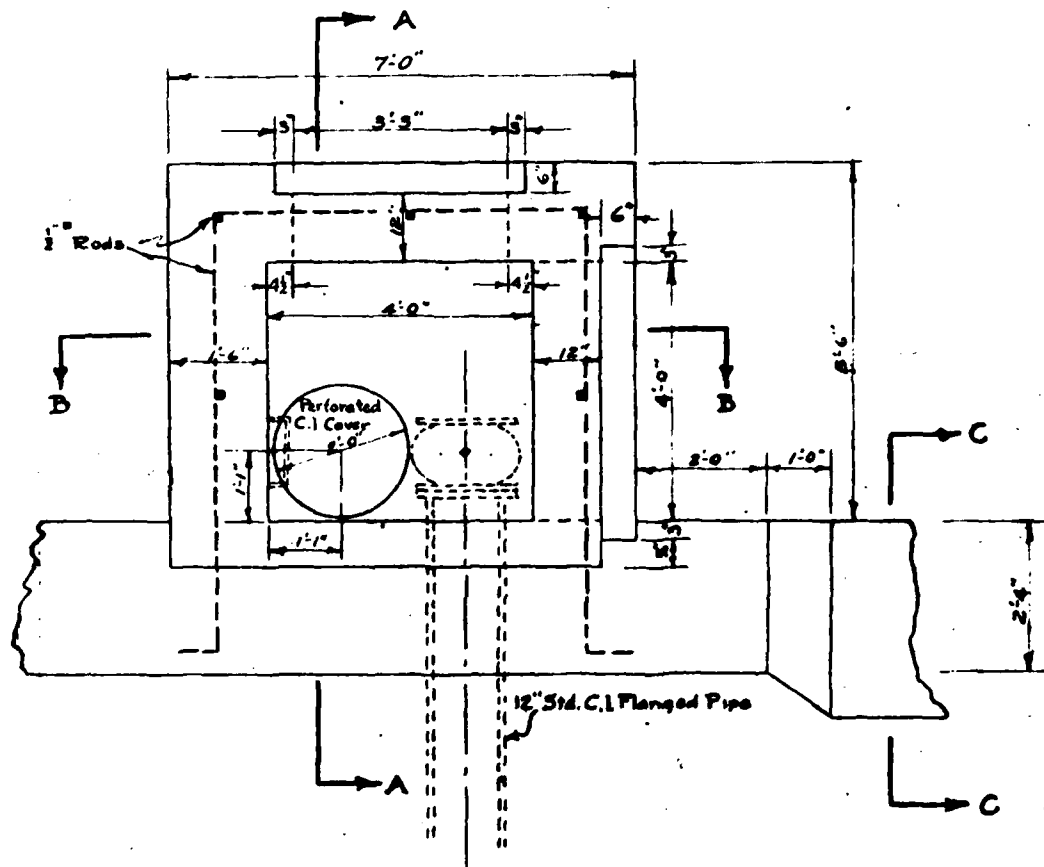


THREE SLUICE GATE



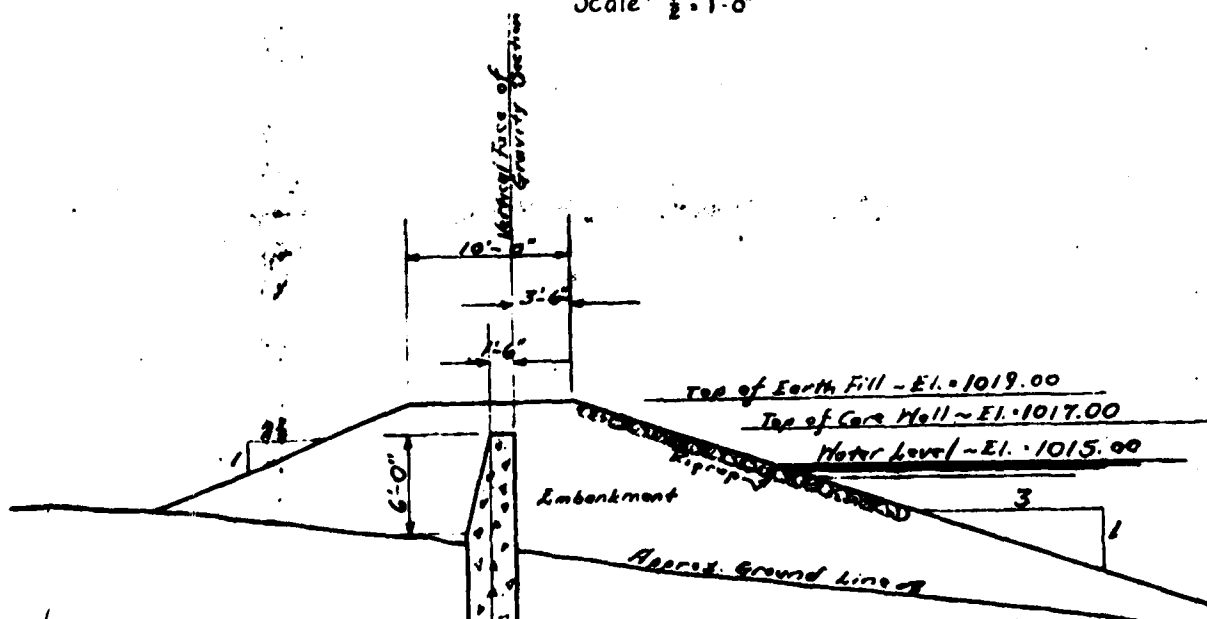
SECTION - XX
Scale: 1/4" = 1'-0"





PLAN OF WELL

Scale: $\frac{1}{2}$ " = 1'-0"



R4-1" Rods 6" Centers
to an elevation
of about 991.50
the rods are to be
placed at 12" Centers

R1-1" Rods placed
vertically at
2' Centers

WELL

Guides

GRAVITY
DAM

Vertical Key

Elev 991.507

Telephone Wire

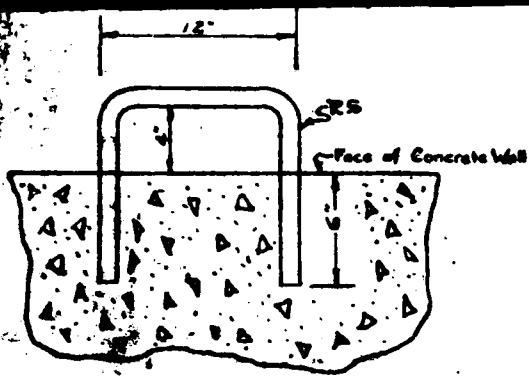
Horizontal Key

Top of Footing Elev 988.07

SECTION-AA

Scale: $\frac{1}{2}$ " = 1'-0"

SECTION-CC



SECTION-XX
Scale: $\frac{1}{2}$ " = 1'-0"

Standard 12"
C.I. Flanged Pipe

Top of Wall Footing

RS

12" Coffin or Ludlow
type gate valve.
Bronze stem and
rings.

Elev 991.50

Elev 983.2

Telephone Wire

SECTION-BB

Scale: $\frac{1}{2}$ " = 1'-0"

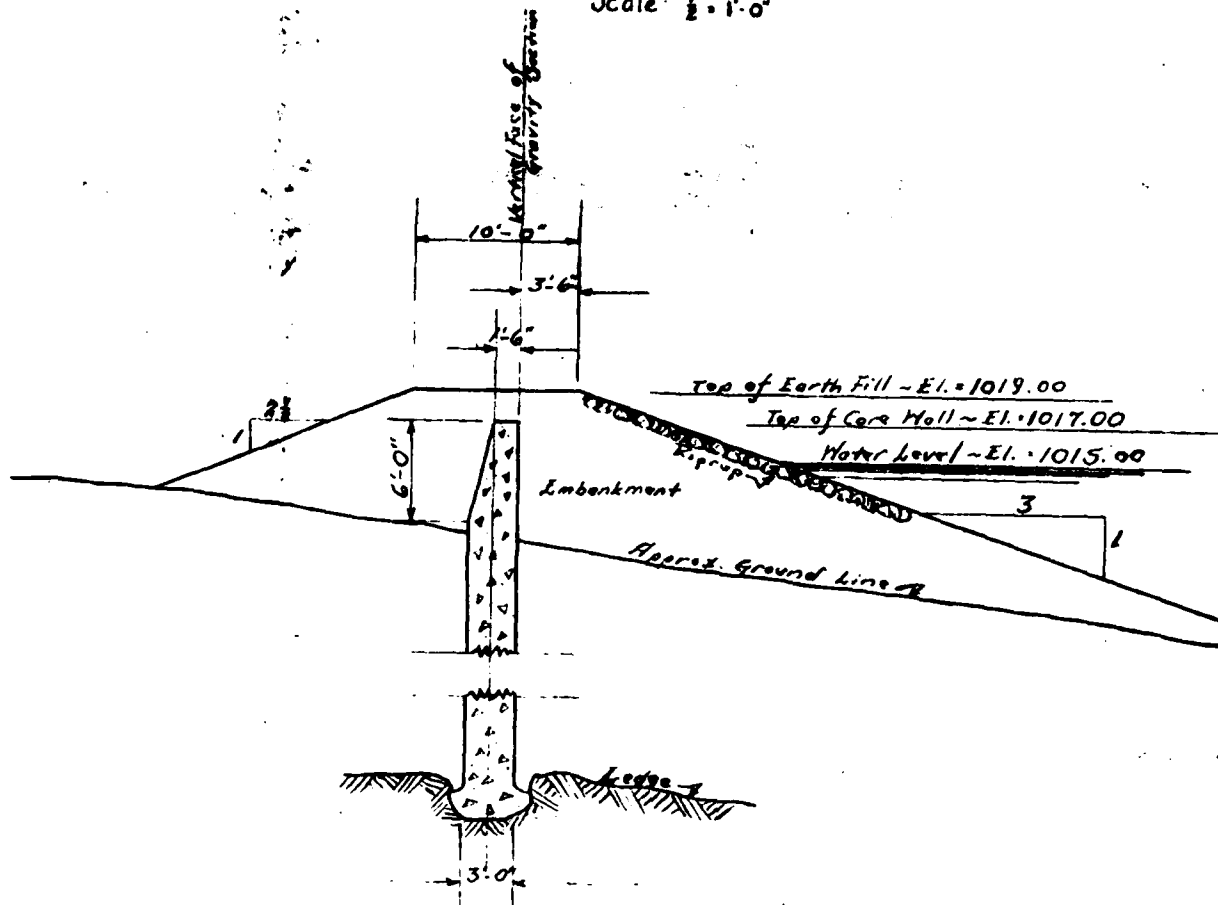
GRAVITY SECTION

Keys at Level Rock

NOTE: Cut Keyways (longitudinal)

PLAN OF WELL

Scale: $\frac{1}{2}$ " = 1'-0"



TYPICAL CORE WALL SECTION

Scale: $\frac{1}{8}$ " = 1'-0"

FOR THE COMMISSIONERS OF THE
PALISADES INTERSTATE PARK

DETAILS OF (WELCH LAKE) BEAVER POND DAM

Scale: as shown

June 1929

Revised Aug. 1933

Wm. A. Welch

Chief Engr.

$\frac{2}{2}$ No. 858-B
RS-FS



Keys at Sloped Rock

1) in rock at base of Dam

DAM-12

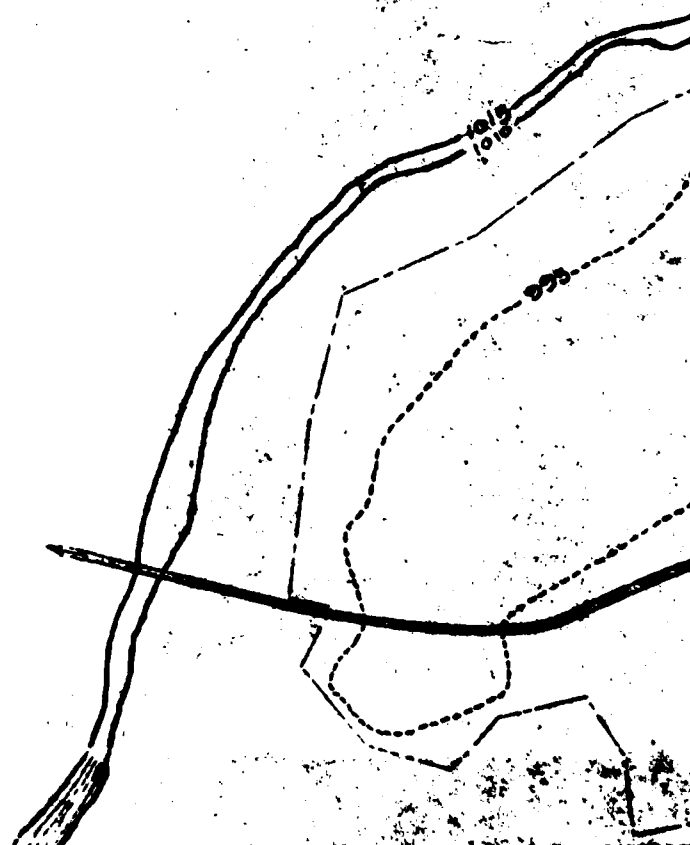
Print received

1

Note Elevations referred to U.S. Geological Survey Datum.

COMPARATIVE TABLE OF DATA			
	CONV. P.L.P.	OLD ELEVATION	DIFFERENCE
Elevation of H.W.	1015	993	22 feet
Max. Height of Dam	32 feet	10 feet	22 feet
Capacity	1,213,725,130 gals.	164,504,000 gals.	1,049,255,130 gals.
Area Water Surface	216 acres	91.5 acres	124.5 acres
Average Depth	27.5 feet	5.5 feet	22 feet
Max. Depth	35 feet	13 feet	22 feet
Area Land owned		108.31 acres	

TOLUPO & SUFFERY



10/15/10

3





ELEVATIONS FROM
THE CONN.

4



CAPACITIES BETWEEN GIVEN ELEVATIONS		
ELEV.	CAPACITIES (GALLONS)	CAPACITIES FROM ELEV. 1015 TO GIVEN ELEV. (GAL)
1015		
	68,840,310	
1014		68,840,310
	65,650,098	
1013		134,490,400
	62,992,820	
1012		197,483,220
	60,498,240	
1011		257,981,460
	58,196,270	
1010		316,177,730
	733,077,400	
993		99,255,130
	164,500,000	
Bottom		55,140

*FOR THE COMMISSIONERS OF THE
PALISADES INTERSTATE PARK*

PROPOSED

LAKE AT BEAVER POND

*TOWNS OF HAVERSTRAW AND STORY POINT
ROCKLAND COUNTY*

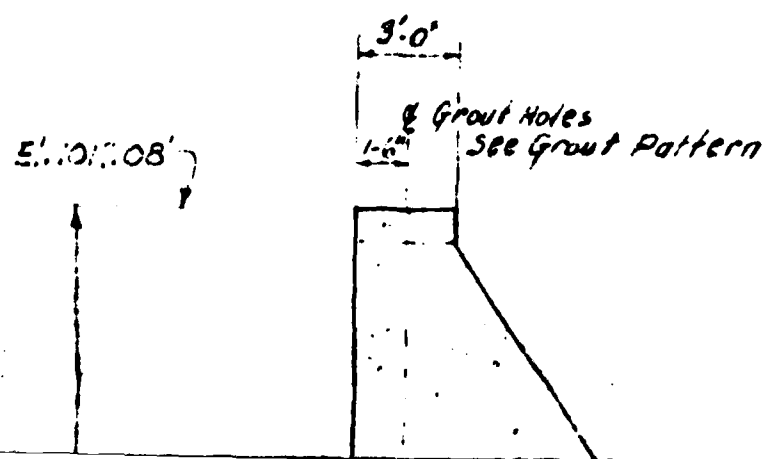
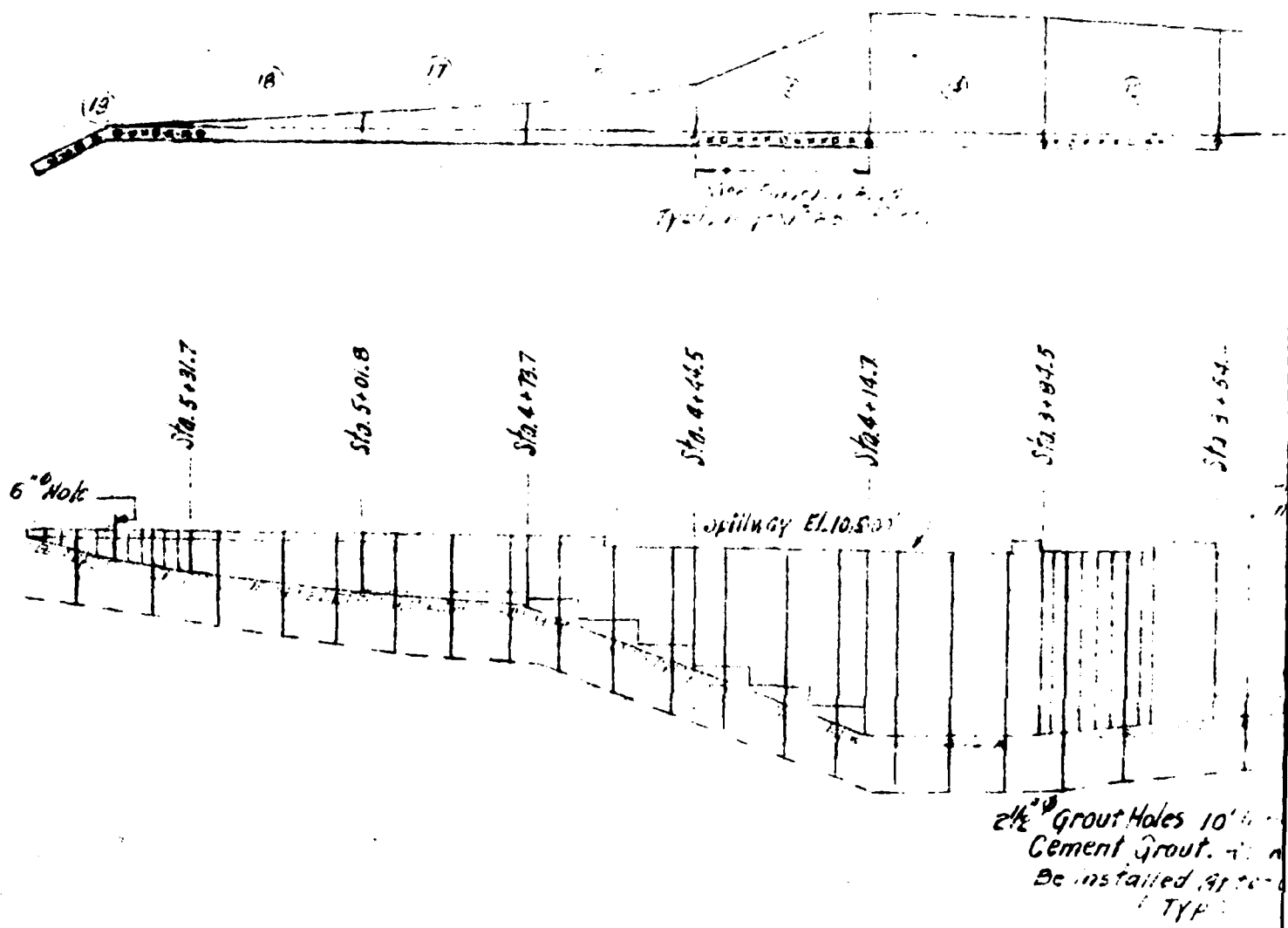
SCALE 1"=200'

Revised - FEB. 1928

*WILLIAM W. WALKER
CHIEF ENGINEER*

6.

1



FLOW

2

PLAN
Scale: 1" = 20'

3'0" Top of Dam

Sta. 3+24.2

Sta. 2+92.1

Sta. 2+62.1

Sta. 2+32.1

Sta. 2+02.2

Sta. 1+72.2

Sta. 1+42.2

Sta. 1+12.4

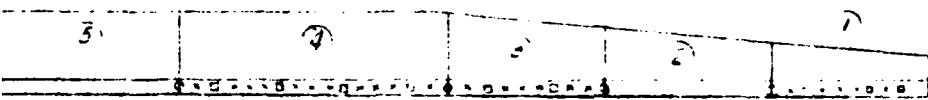
2'2" Grout Hole To Rock
(Concrete Grout)

Top of Dam El. 1017.08'

ELEVATION
Upstream Face
Scale: 1" = 20'

Grout
Hole
in concrete
to
grouting.

3



Sta. 1+12.4

Sta. 1+72.6

Sta. 1+46.7

Sta. 1+0.0

Sta. 1+0.0



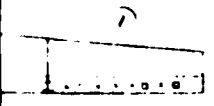
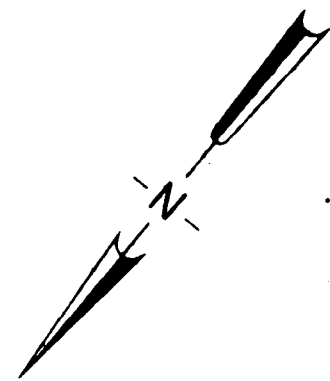
Ø Bolt & Grout Hole

3" Minimum Cover 14" Dia.

LEGEND

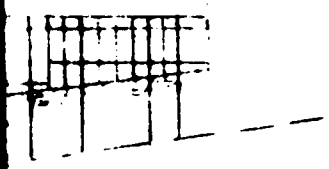


3

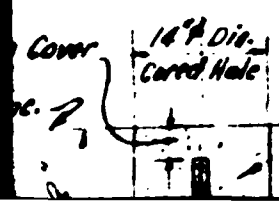


10' 0" x 23'

10' 0" x 23'



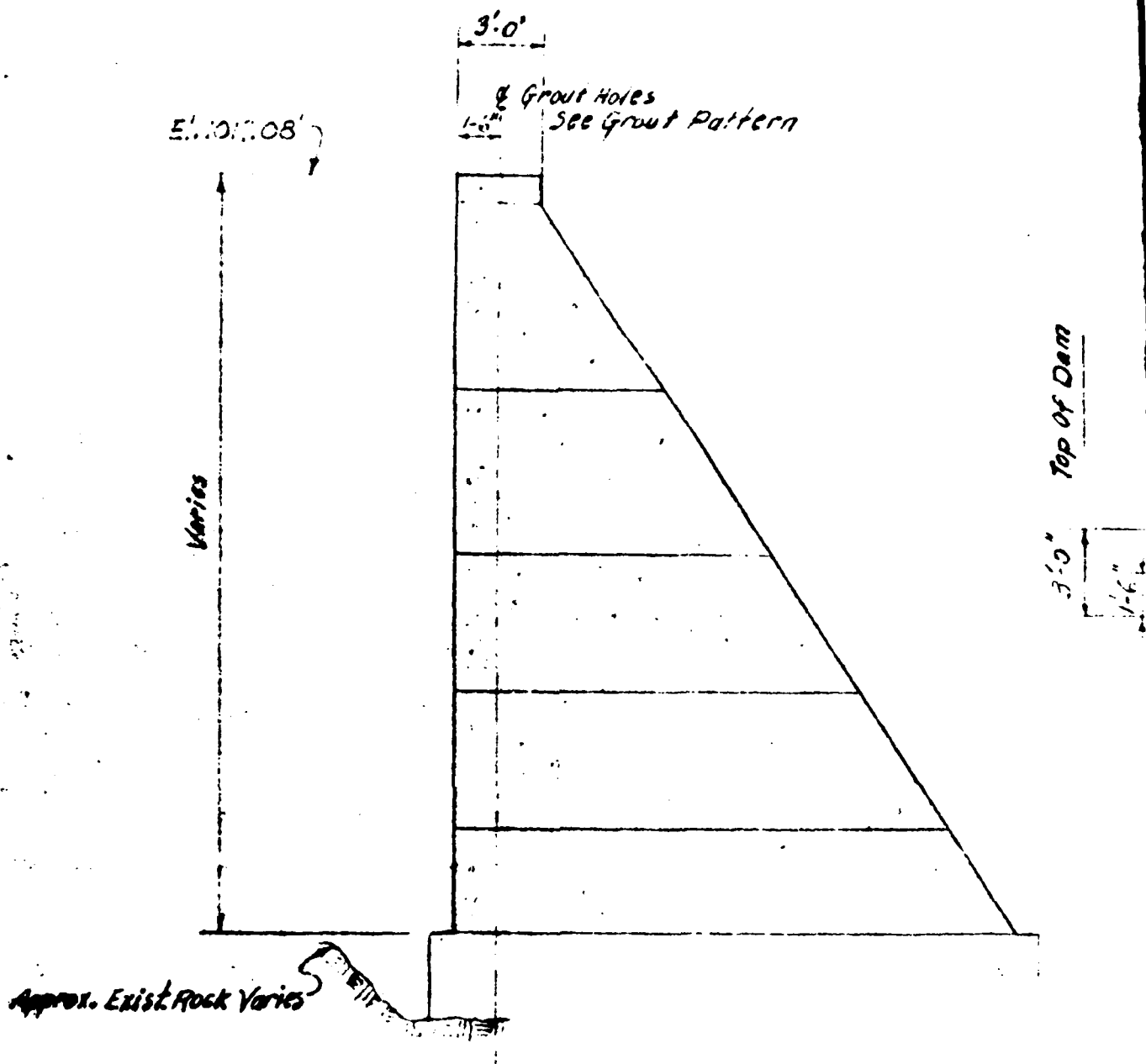
1 Bolt & Grout Hole



Fill With Conc.
After Tensioning
& Grouting Bolt

LEGEND

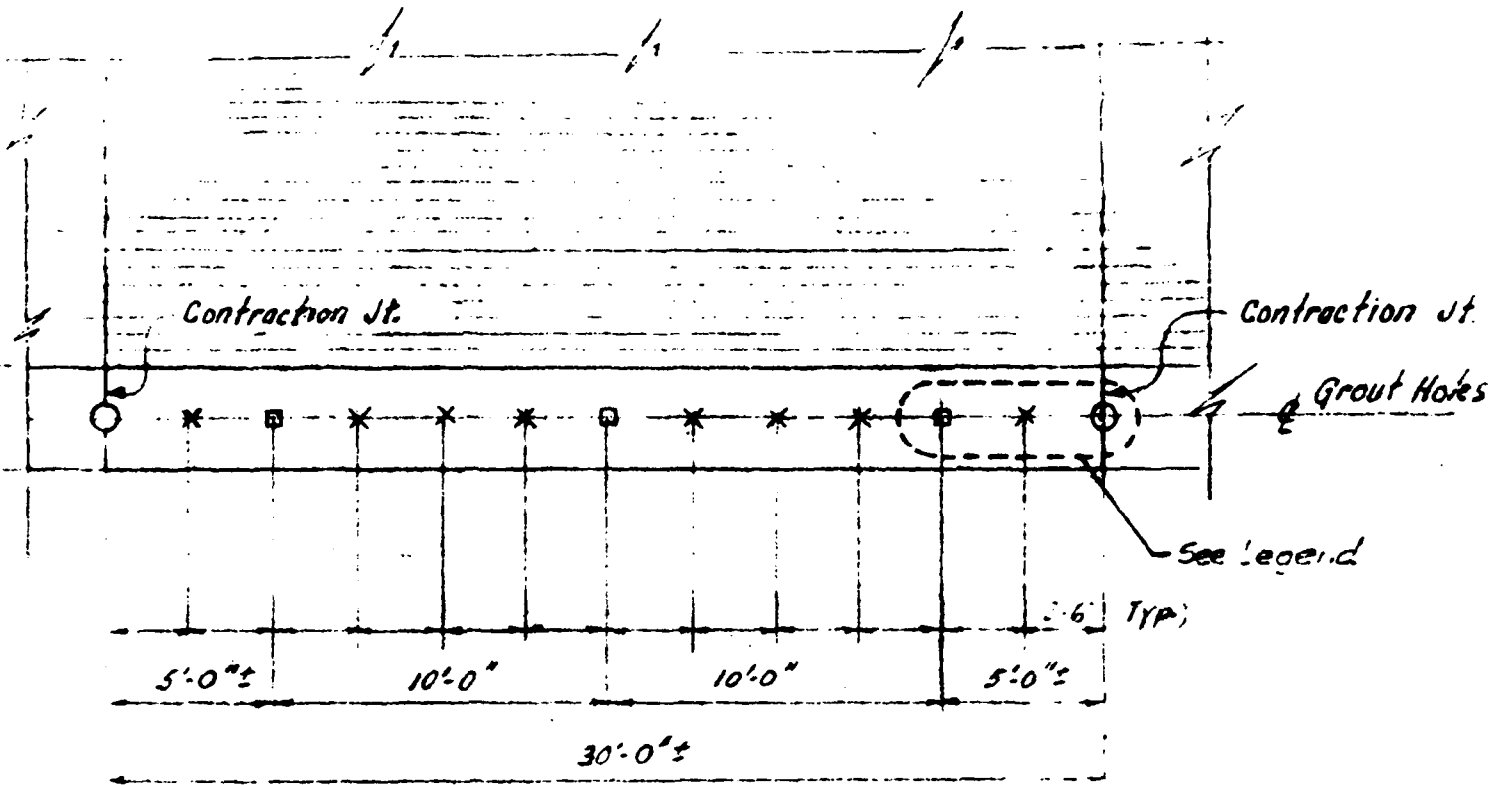
- = 6" Hole To Be Filled With Non-Setting Grout
- = 2 1/2" Grout Hole 10 Feet Into Wall To Be Grouted With Cement Grout After Bolt Is Installed After Grouting.
- x = 2 1/2" Grout Hole To Be Grouted After Bolt Is Installed



TYPICAL DAM CROSS SECTION
Scale 1/4" = 1'-0"

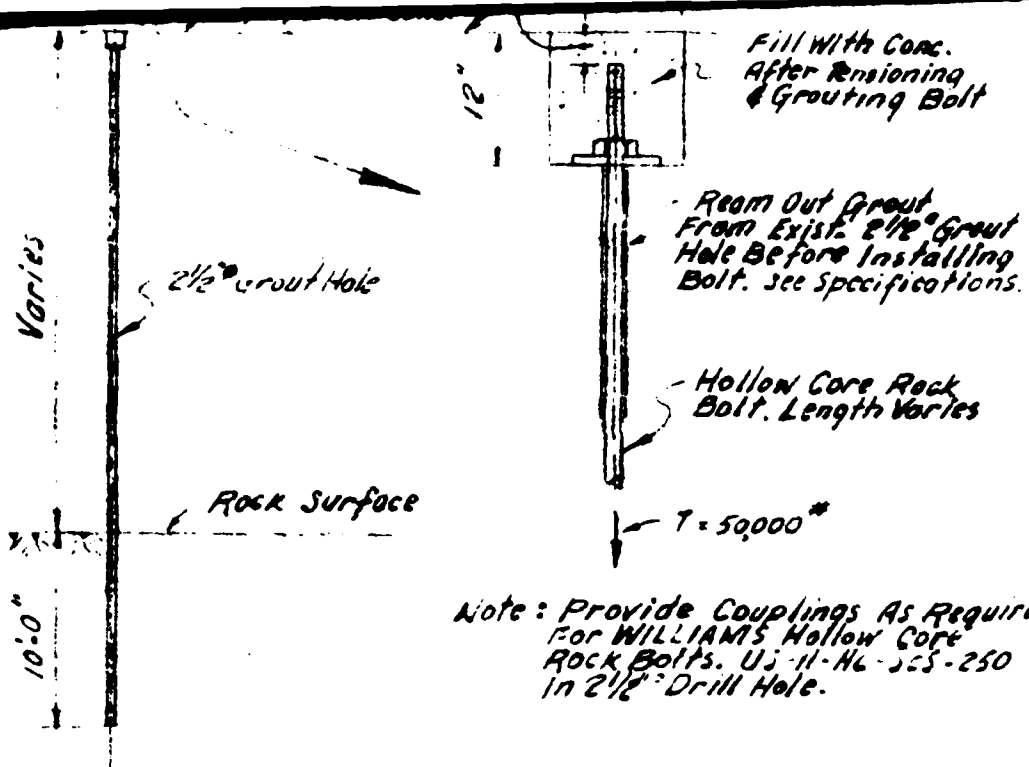
5

Upstream Face
Scale: 1"=20'



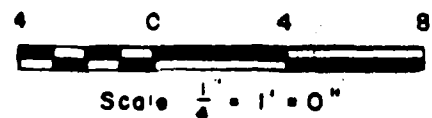
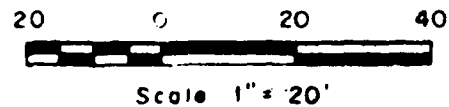
TYPICAL GROUT HOLE PATTERN
BAYS ① TO ⑪
Scale 4"=1'-0"

6

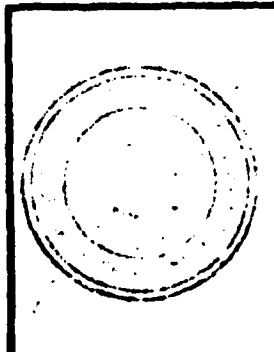


Note: Provide Couplings As Required For WILLIAMS Hollow Core Rock Bolts. UJ-11-H6-SS-250 in 2 1/2" Drill Hole.

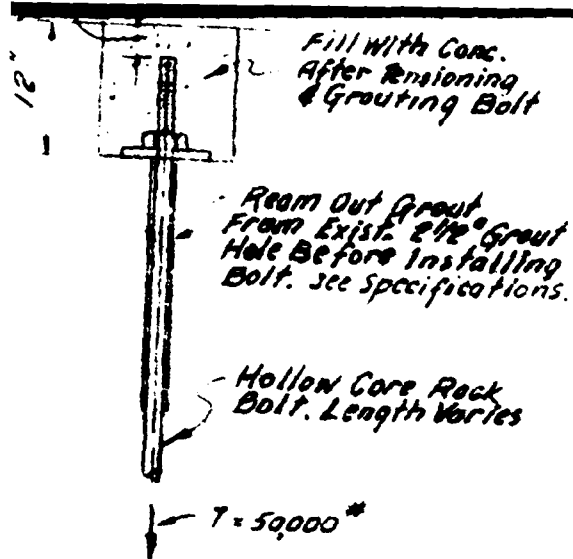
ROCK BOLT DETAIL No scale



7



				PALIS
				BEAR
				LAK
				M
				CHAS. T
				BOSTON, MASS.
4-18-78	Construction	NO.	REVISIONS	DATE
DATE	ISSUED FOR	DRAWN	CHECKED	
DATE MADE	4-18-78	IN CHARGE	APPROVED	



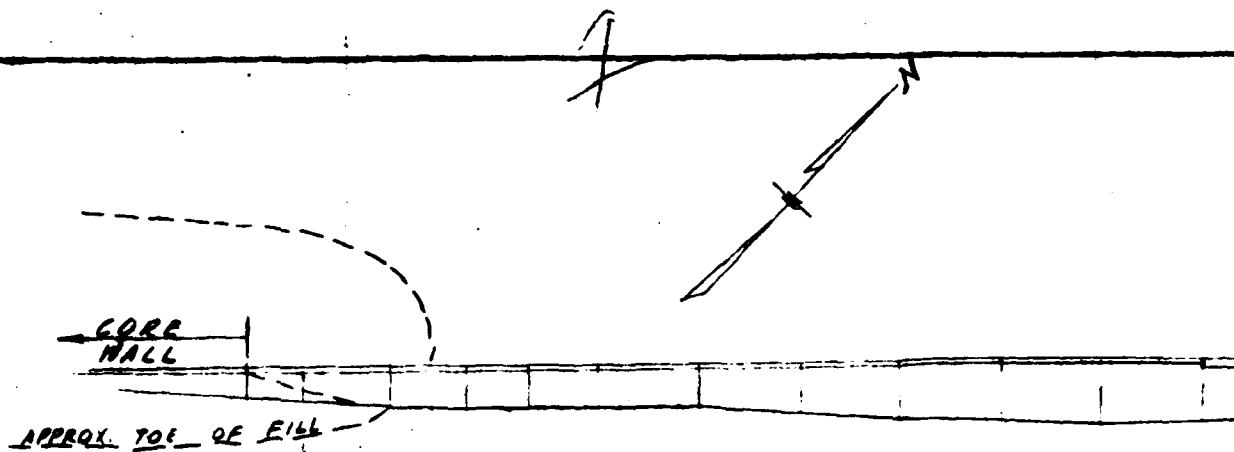
X = 2 1/2" Grout Hole To Rock To Be Chemically Grouted.

Note: Provide Couplings As Required
For WILLIAMS Hollow Core
Rock Bolts. US-11-H6-SS-250
In 2 1/2" Drill Hole.

K BOLT DETAIL

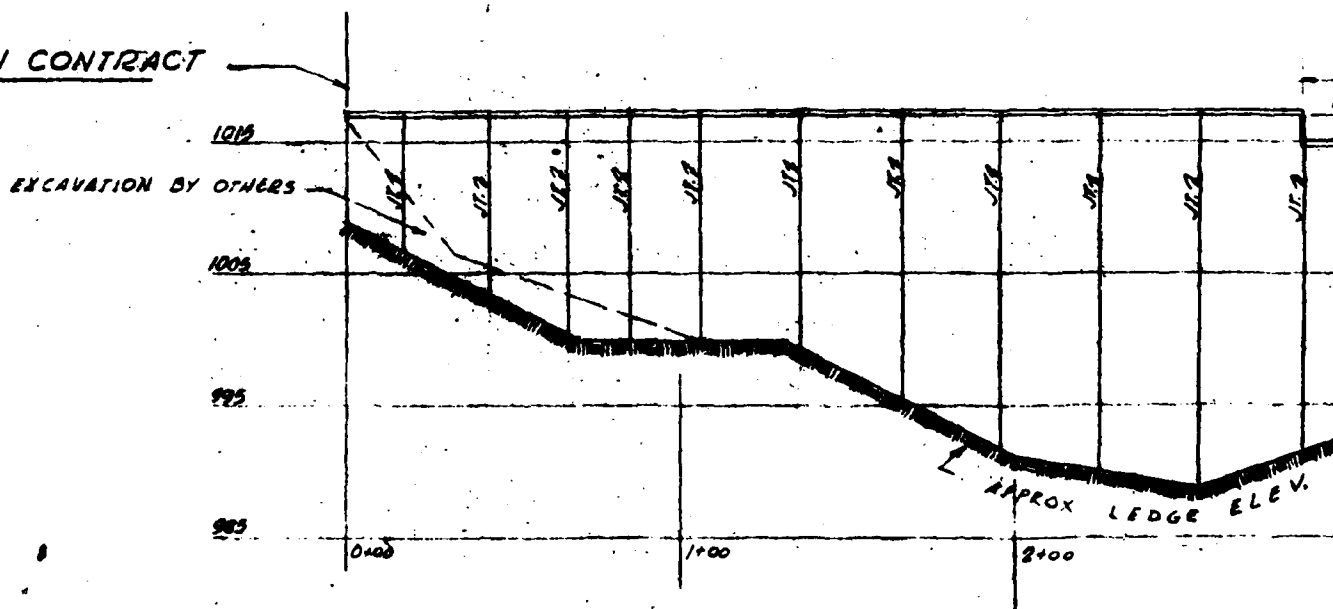
No scale

RECID MAY 9, 1978
Finn
DRAWS
USF

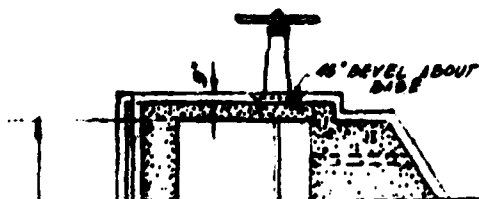


PLAN
SCALE: 1" = 40'

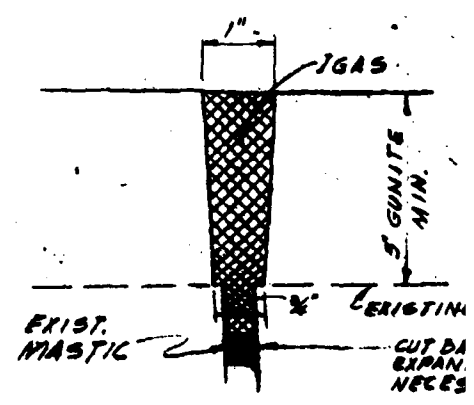
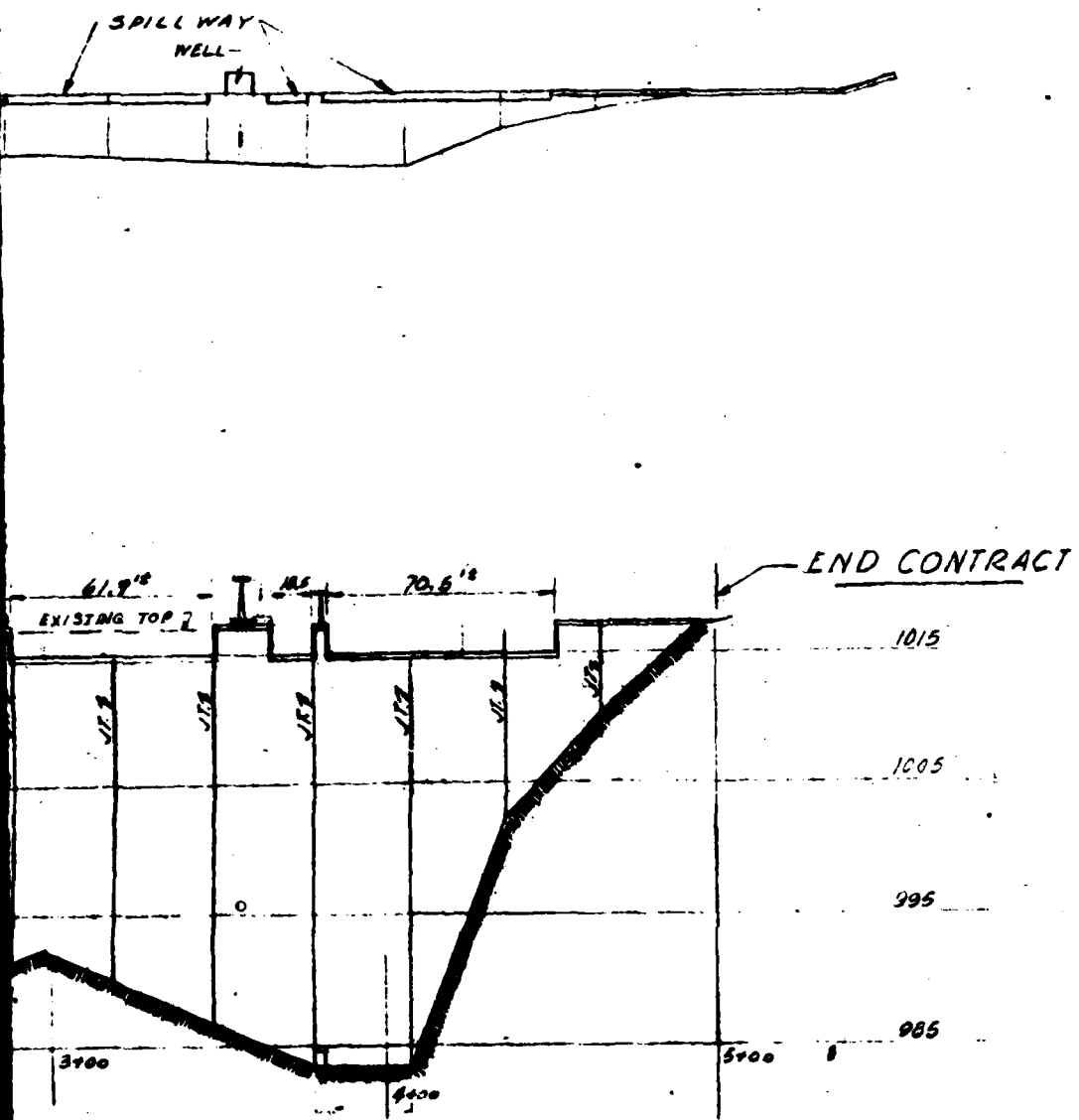
BEGIN CONTRACT



PROFILE
SCALE: HOR. 1" = 40'
VERT. 1" = 10'



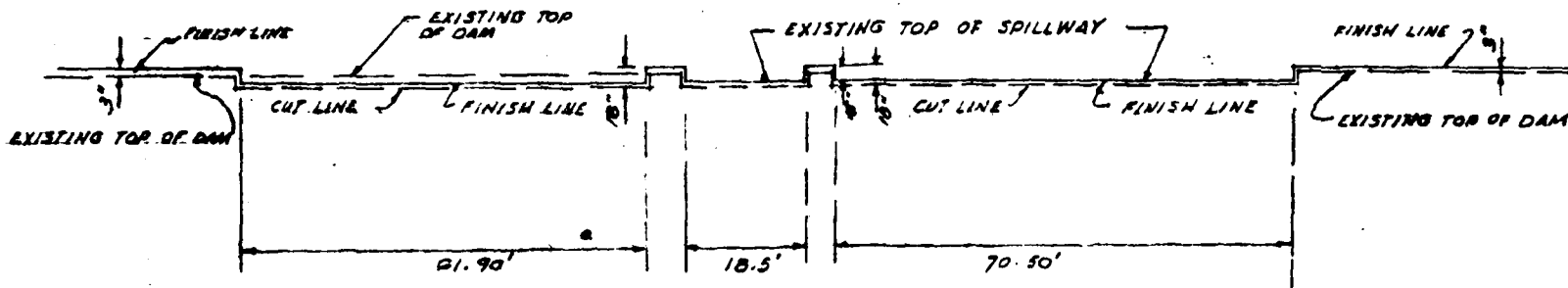
2



DETAIL OF EXPANSION

SCALE 1/8" = 1'-0"

3



• SPILLWAY •
 • EXISTING CONCRETE TO BE REMOVED •
 ITEM # 80 A
 SCALE 1" = 20'

5' MIN.

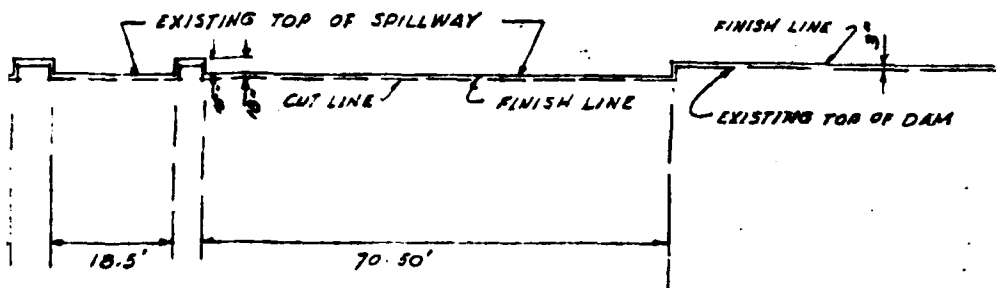
EXISTING DAM

CUT BACK INTO EXISTING
 EXPANSION JOINT WHERE
 NECESSARY A.O.B.E

VISION JOINT

7'-0"

4



SPILLWAY
CONCRETE TO BE REMOVED
M. 80 A
LE 1" 20'

7'-0"

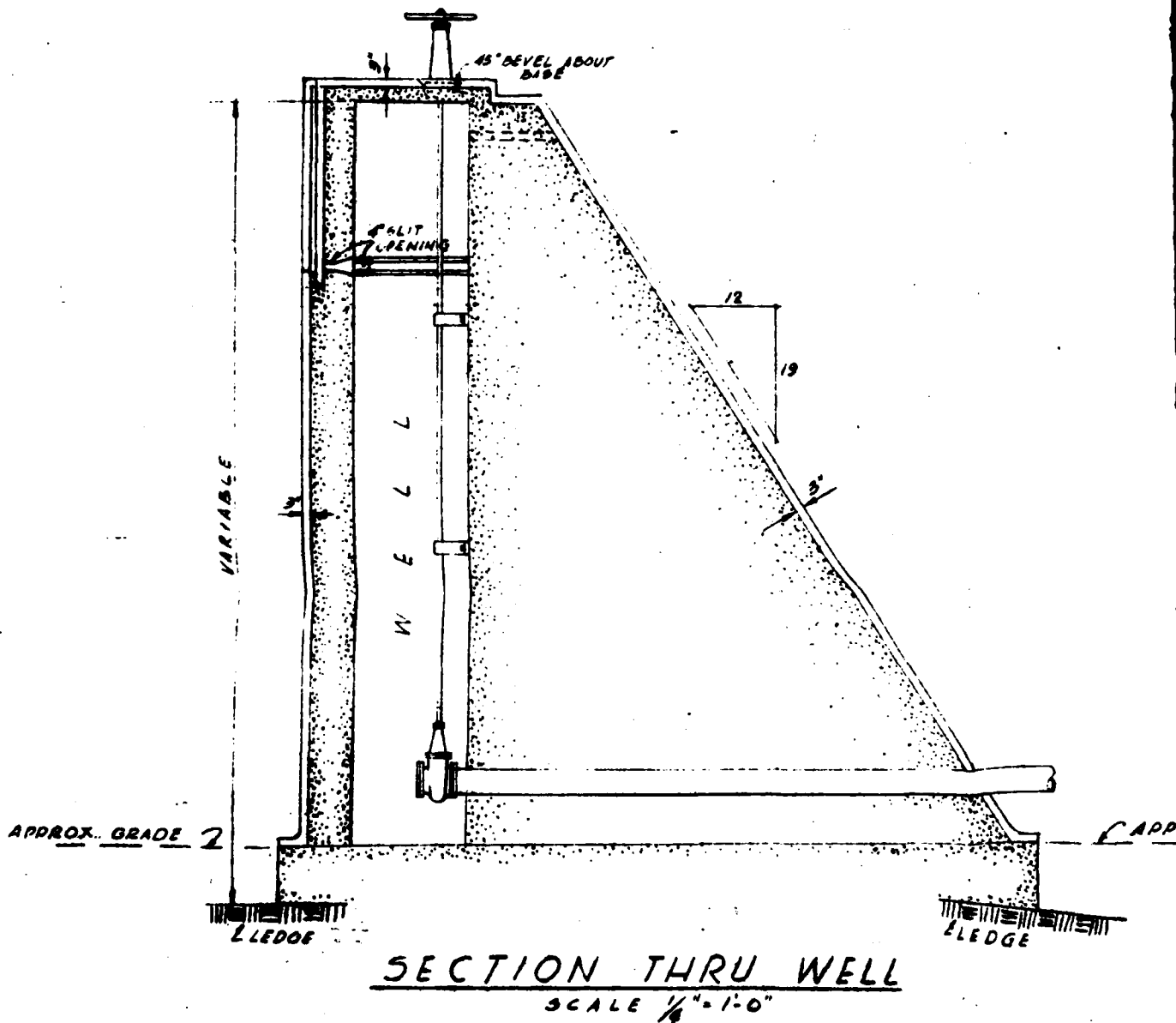
1/4" HOOKED EXPANSION BOLTS

0+00

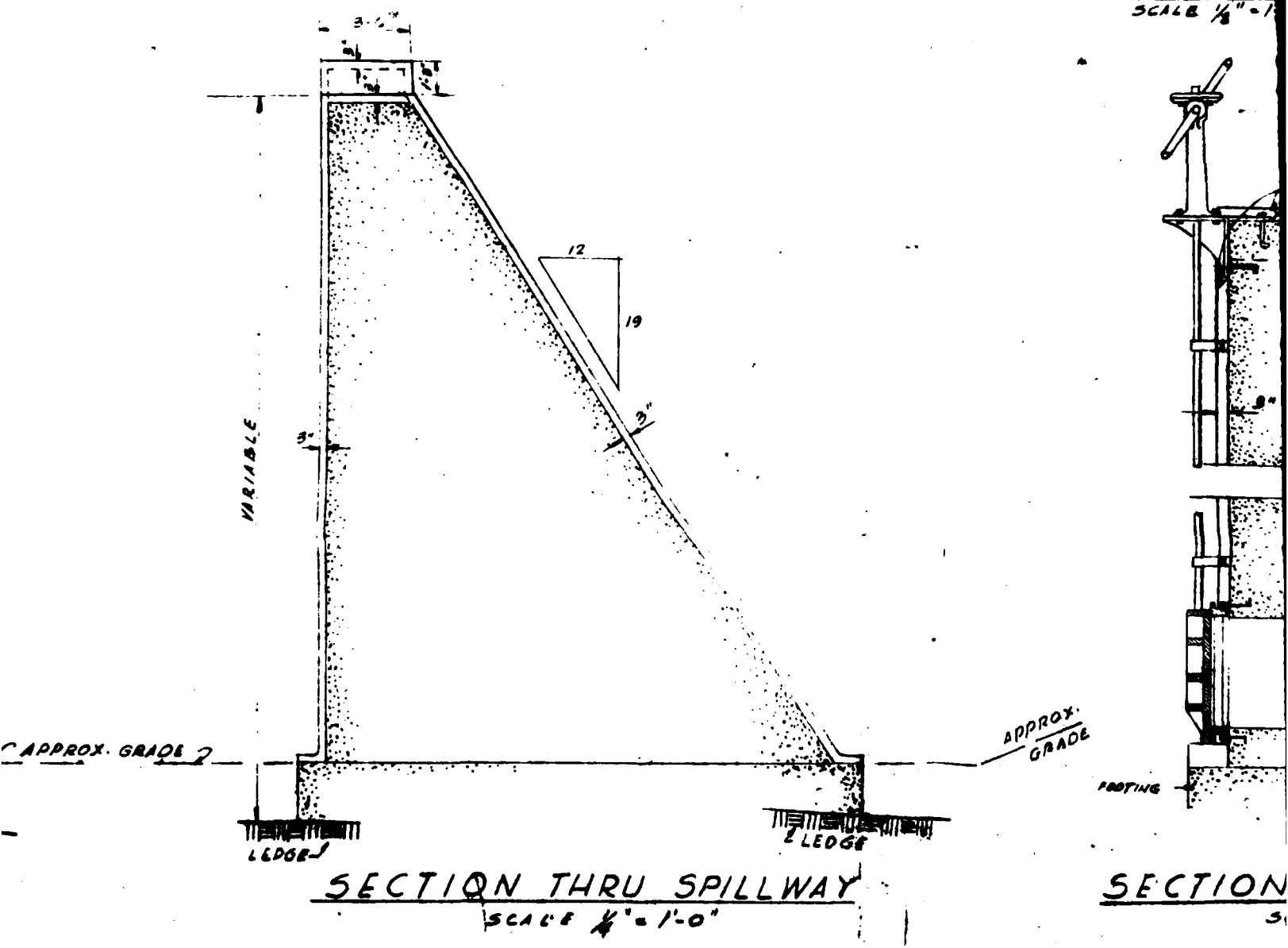
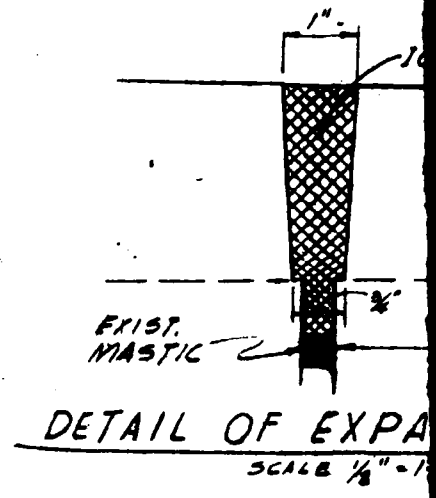
1+00

2+00

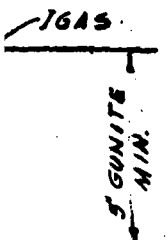
PROFILE

SCALE: HOR. 1" = 100'
VERT. 1" = 10'

FILE
 2. 1" = 40'
 1. 1" = 10'



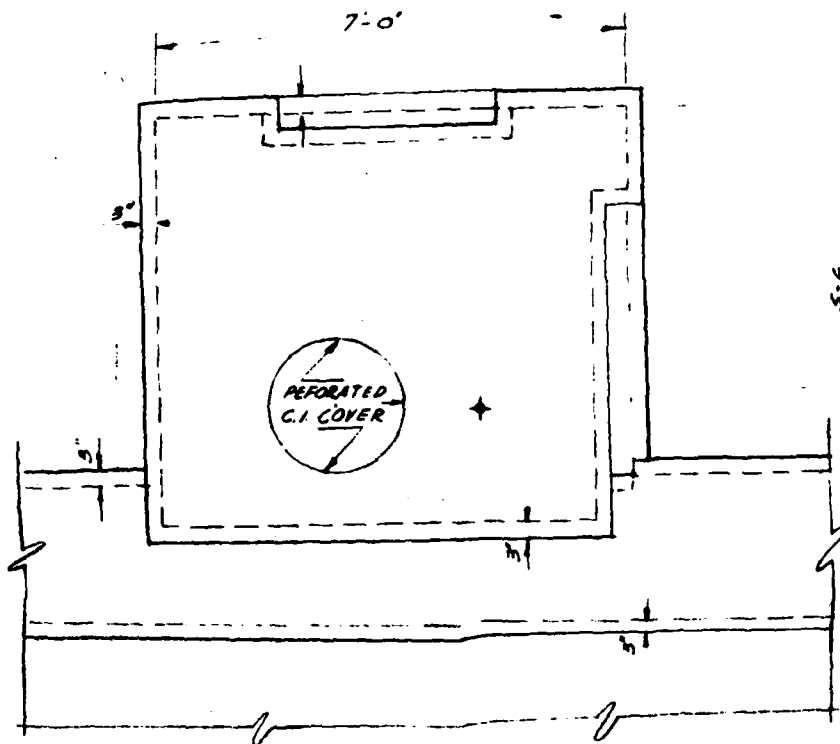
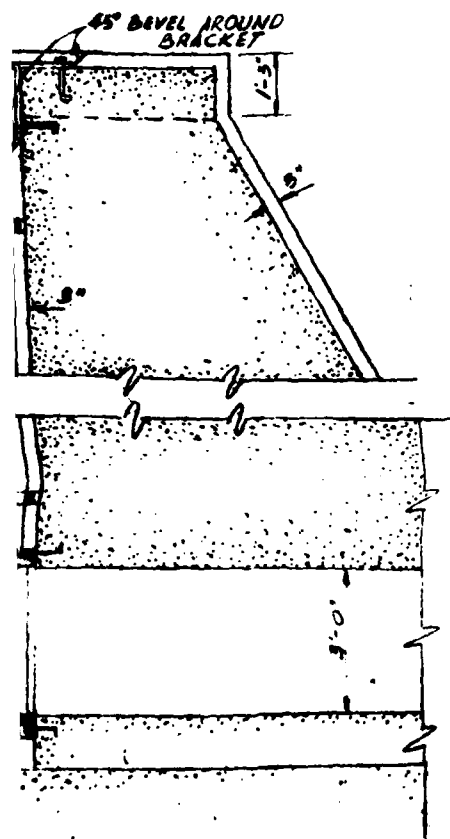
SCALE 1" = 20'



CUT BACK INTO EXISTING
EXPANSION JOINT WHERE
NECESSARY A. O. B. E

EXPANSION JOINT

1" = 1'-0"



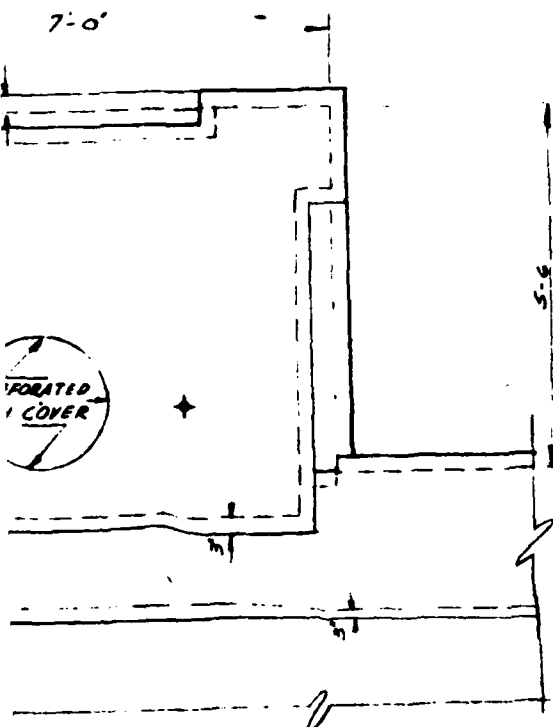
PLAN OF WELL

SCALE 1/2" = 1'-0"

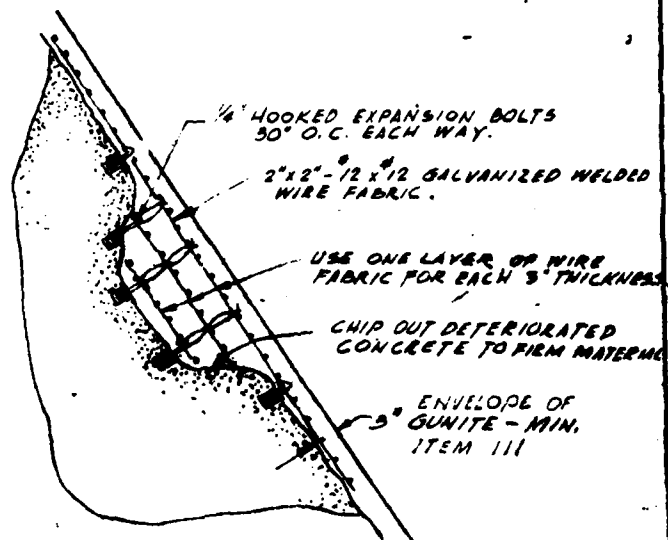
ION THRU SLUICE GATE

SCALE 3/8" = 1'-0"

DRAWN	
CHECKED	
DATE	



PLAN OF WELL
SCALE $\frac{1}{2}" = 1'-0"$



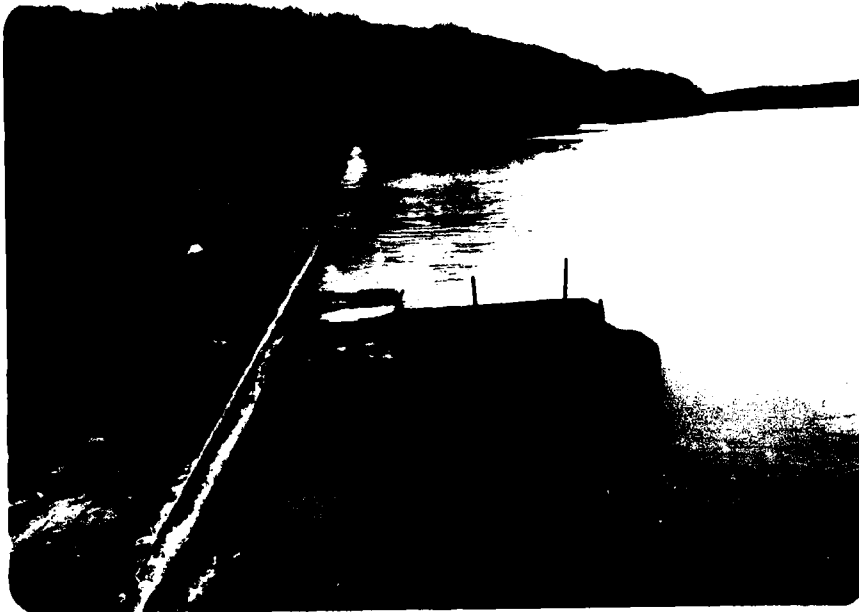
TYPICAL DAM REPAIR
NOT TO SCALE

REPAIR - LAKE WELCH DAM
HARRIMAN STATE PARK ROCKLAND CO.
NEW YORK

DESIGNED BY	TITLE	DRAWING No.
DRAWN BY	DETAILS OF DAM REPAIRS	2
TRACED BY		
CHECKED BY		
DATE		
7/17/54		15 SHEETS
PALISADES INTERSTATE PARK COMMISSION DEAR MOUNTAIN NEW YORK		

PHOTOGRAPHS

APPENDIX B



2. VIEW OF CREST OF SPILLWAY AND
INTAKE STRUCTURE FOR HIGH LEVEL
OUTLET.



3. VIEW OF DOWNSTREAM CHANNEL.
NOTE VEGETATION.



4. VIEW OF DOWNSTREAM FACE OF DAM.
NOTE SEEPAGE THROUGH CONSTRUCTION
JOINT AND GUNITE SURFACE REMOVED.



5. VIEW OF DOWNSTREAM FACE OF SPILL-
WAY AND HIGH LEVEL OUTLET. NOTE
FLOW THROUGH OUTLET AND THE EXPOSED
ROCK OF THE DOWNSTREAM CHANNEL.



6. VIEW AT DAM CREST. NOTE GUNITE
SURFACE OVER THE CONCRETE.



7. VIEW OF OPERATING MECHANISM FOR
SLUICE GATE. (RESERVOIR DRAIN)



8. VIEW OF CREST AND DOWNSTREAM FACE
OF EARTH EMBANKMENT. (LOOKING RIGHT)

VISUAL INSPECTION CHECKLIST

APPENDIX C

VISUAL INSPECTION CHECKLIST

1) Basic Data

a. General

Name of Dam LAKE WELCH (FORMERLY KNOWN AS BEAVER POND DAM)

Fed. I.D. # NY 283 DEC Dam No. 196-854

River Basin HUDSON

Location: Town LETCHWORTH VILLAGE County ROCKLAND

Stream Name MINISCEONGO CREEK

Tributary of HUDSON RIVER

Latitude (N) 41° 13' 44" Longitude (W) 74° 4' 20"

Type of Dam CONCRETE GRAVITY & EARTH WITH CENTRAL CONCRETE CORE WALL.

Hazard Category HIGH

Date(s) of Inspection APRIL 24, 1980

Weather Conditions 75° SUNNY

Reservoir Level at Time of Inspection 1015.1 FT. (MSL)

b. Inspection Personnel TONY DOLICUMASCOLO AND JYOTINDRA PATEL

c. Persons Contacted (Including Address & Phone No.)

ROBERT SANTORO, SENIOR PARK ENGINEER, PALISADES
INTERSTATE PARK COMMISSION, ADMINISTRATION BUILDING,
BEAR MOUNTAIN, NY 10911. PHONE NO. (914) 786-2701

d. History:

Date Constructed 1929-1937 Date(s) Reconstructed 1959 and 1978

Designer MR. L. A. WELCH

Constructed By UNKNOWN

Owner NEW YORK STATE PARKS & RECREATION
PALISADES INTERSTATE PARK COMMISSION

2) Embankment — EARTH WITH CENTER CONCRETE CURB (225 FT. LONG)
WALL

a. Characteristics

- (1) Embankment Material _____

(2) Cutoff Type NONE

(3) Impervious Core CONCRETE COREWALL LOCATED IN THE
CENTER OF EMBANKMENT
(4) Internal Drainage System NONE

(5) Miscellaneous —

b. Crest

- (1) Vertical Alignment GOOD

(2) Horizontal Alignment STRAIGHT AND ALIGNMENT GOOD

(3) Surface Cracks NONE OBSERVED

(4) Miscellaneous —

c. Upstream Slope

- (1) Slope (Estimate) (V:H) _____
(2) Undesirable Growth or Debris, Animal Burrows _____

(3) Sloughing, Subsidence or Depressions NONE OBSERVED

(4) Slope Protection NONE

(5) Surface Cracks or Movement at Toe NONE OBSERVED

d. Downstream Slope

(1) Slope (Estimate - V:H) _____

(2) Undesirable Growth or Debris, Animal Burrows LARGE BUSHES AND
A FEW SAPLING SIZE TREES.

(3) Sloughing, Subsidence or Depressions NONE OBSERVED

(4) Surface Cracks or Movement at Toe NONE OBSERVED

(5) Seepage NONE OBSERVED

(6) External Drainage System (Ditches, Trenches; Blanket) NOT
APPLICABLE

(7) Condition Around Outlet Structure NOT APPLICABLE

(8) Seepage Beyond Toe NONE OBSERVED.

e. Abutments - Embankment Contact (SOUTHERLY). NORTHERLY CONTACT
IS WITH CONCRETE GRAVITY DAM.

(1) Erosion at Contact NONE OBSERVED

(2) Seepage Along Contact NONE OBSERVED

3) Drainage System — NONE

a. Description of System _____

b. Condition of System _____

c. Discharge from Drainage System _____

4) Instrumentation (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.) _____

NONE

5) Reservoir

- a. Slopes WITHIN VICINITY OF THE DAM RESERVOIR SLOPES
ARE STABLE AND NO INCIDENCE OF ADVERSE CONDITION REPORTED
TO THE OWNER.
- b. Sedimentation NO EVIDENCE OF EXCESSIVE SEDIMENTATION
OBSERVED. LAKE WATER RELATIVELY CLEAR; NO FLOATING DEBRIS
OBSERVED.
- c. Unusual Conditions Which Affect Dam

6) Area Downstream of Dam

- a. Downstream Hazard (No. of Homes, Highways, etc.) WELCH CAMP SITE;
SEVERAL HOMES; STATE RT. 210 AND PALISADES INTERSTATE PARKWAY.
- b. Seepage, Unusual Growth NO SEEPAGE OBSERVED. NO UNUSUAL
GROWTH
- c. Evidence of Movement Beyond Toe of Dam NONE OBSERVED
- d. Condition of Downstream Channel CHANNEL IS ALSO SPILLWAY CHANNEL
WHICH IS OVERGROWN WITH TREES AND OTHER VEGETATION. (ALSO SEE
ITEM #7.

7) Spillway(s) (Including Discharge Conveyance Channel)

- SPILLWAY IS BROAD CRESTED WEIR AND IS PART
OF CONCRETE DAM.
- a. General THE ORIGINAL SPILLWAY WAS REHABILITATED
BY APPLYING A GUNITE SURFACE
- b. Condition of Service Spillway GENERALLY IN GOOD
CONDITION. FEW FEET OF GUNITE ^{SURFACE} IS NOT EXISTING
ALONG THE CREST OF THE SPILLWAY (SEE PHOTOGRAPH)

c. Condition of Auxiliary Spillway NOT APPLICABLE

d. Condition of Discharge Conveyance Channel IN VICINITY OF DAM THE CHANNEL BANKS AND FLOOR OF CHANNEL IS ROCK AND IS IN GOOD CONDITION. OVERGROWN WITH TREES AND OTHER VEGETATION.

8) Reservoir ~~Outlet~~ ^{and} LOW LEVEL - 3' X 3' SLUICE WAY ①
HIGH LEVEL - 12" CI OUTLET PIPE ②

Type: Pipe ② Conduit Other SLUICEWAY ①

Material: Concrete ② Metal ① Other

Size: AS NOTED ABOVE Length

Invert Elevations: Entrance ① 984.0 ② 1010 Exit ① 984.0 ② 991.5±

Physical Condition (Describe): Unobservable ① & ② except mt. below.

Material: —

Joints: — Alignment —

Structural Integrity: CONCRETE WALLS OF SLUICEWAY ARE IN GOOD CONDITION.

Hydraulic Capability: —

Means of Control: Gate ② Valve ① Uncontrolled

Operation: ^{Reported} Operable ① Inoperable ② Other

Present Condition (Describe): CONTROL FOR HIGHLEVEL IS NOT EXISTING EXCEPT THE STEM; SLUICEGATE CONTROL IN GOOD CONDITION AND REPORTED OPERABLE

9) Structural

- a. Concrete Surfaces ORIGINAL CONCRETE DAM RESURFACED
WITH GUNIT (3 inches). MOST OF WHICH HAS BEEN
REMOVED AT DOWNSTREAM FACE. THE CONDITION
EXPOSE CONCRETE IS GOOD.
- b. Structural Cracking NONE OBSERVED
- c. Movement - Horizontal & Vertical Alignment (Settlement) NONE
- d. Junctions with Abutments or Embankments NO EVIDENCE
OF PROBLEMS
- e. Drains - Foundation, Joint, Face NONE
- f. Water Passages, Conduits, Sluices 2 OUTLETS - HIGH LEVEL
OUTLET & LOW LEVEL OUTLET ARE 12 inch CI PIPE
ADD 3 FT SQUARE SLICeway. THE CONDITION OF
HIGH LEVEL OUTLET UNDETERMINED; SLICeway IN
SATISFACTORY CONDITION
- g. Seepage or Leakage MINOR SEEPAGE OBSERVED AT THE
MONOLITH & CONSTRUCTION JOINTS.

- h. Joints - Construction, etc. SOME JOINTS FILLED WITH
GRAVEL TO PREVENT SEEPAGE.
- i. Foundation IS ROCK ACCORDING TO AVAILABLE
DOCUMENTS & VISUAL INSPECTION OF DOWNSTREAM
DAM
- j. Abutments NO EVIDENCE OF SEEPAGE
- k. Control Gates HIGH LEVEL OUTLET - INOPERABLE
LOW LEVEL OUTLET IS REPORTED OPERABLE
- l. Approach & Outlet Channels NONE
- m. Energy Dissipators (Plunge Pool, etc.) NONE
- n. Intake Structures FOR HIGH LEVEL OUTLET ; STRUCTURE
COMPLETED FULL OF WATER.
- o. Stability THERE ARE NO VISUAL INDICATIONS THAT SPILLWAY
SHOWS ANY EVIDENCE OF STABILITY PROBLEMS
- p. Miscellaneous

HYDROLOGIC DATA AND COMPUTATION

APPENDIX D

TAMS

Job No. 1551
 Project LAKE WELCH PHASE I INSPECTION
 Subject LOCATION LAT 41° 13' 45" LONG 74° 4' 15"

Sheet 1 of 4
 Date MAY 14 1980
 By D.L.C.
 Ch'k. by _____

EM 1110-2-1405

$$L = 9.5'' = 3.6 \text{ miles}$$

$$L_{CA} = 2.9'' = 1.1 \text{ miles}$$

$$T = C_r (L L_{CA})^{.5}$$

$$= 3.02 \text{ hours}$$

$$t_a = 3.02 / 5.5 = 0.5 \text{ hours}$$

$$q_p = \frac{640 C_r}{t_p} = \frac{400}{3.0} = 133 \text{ cfs/sq mi}$$

$$Q_p = 133 \times 2.87 = 382 \text{ cfs}$$

$$\text{Use } C_r = 2 \\ 640 C_r = 400$$

HYDROMET REPORT NO. 51.

PMP 24 hour 200 SLM INDEX RAINFALL = 24.5"

10 SRM.	6 HR	12 HR	24 HR	48 HR
	26	30	33	37
% index ppt.	106.1	122.4	134.7	151.

TAMS

Job No. 1551-11
 Project LAKE WELCH PHASE I INSPECTION.
 Subject EL - AREA - STORAGE RELATION

Sheet 2 of 4
 Date MAY 14 1980
 By DLC
 Ch'k. by _____

EL	A H	AREA	MEAN AREA	A STORAGE	STORAGE.	(* Ref 5)
986		0				
1010		186			3444*	
	5		202	1010		
1015		218			4454	
	1		221.5	221.5		
1016		225			4675.5	1016.5 4791.3
	2		231.5	463		
1018		238			5138.5	
	2		244.5	489		
1020		251			5627.5	

Total Surchage Storage 5630 - 4450 = 1180 Acre feet
 ~ 7.7 inches of R/O

CROSS SECTIONS BELOW DAM (Minisceongo. Creek)

400+ft		26+00		52+00		76+00	
		1120	960				
3130	1020	1180	940	720	8760		560
3280	1000	1250	920	700	8820	7500	540
3380	980	1370	917	680	8860	7600	520
3385	976	1440	917	660	8930	7680	500
3450	976	2000	960	640	9000	8000	480
3500	970	2090	920	620	9120	8100	500
3590	950	2150	940	610	9250	8110	505
3630	1000	2200	960	700	9320	8160	505
3690	1000			720	9400	8210	520
						8270	540

TAMS

Job No. 1551-11

Project LAKE WELCH PHASE 1 INSPECTION

Subject _____

Sheet 3 of 4

Date MAY 14 1980

By D L C

Ch'k. by _____

BRAND CRESTED CREST EL 1015.
SPILLWAY LENGTH 152.0'
LISE C = $0.85 \times 3.087 = 2.624$
EL H_s Q_s H_o Q_g
L = 411

DAM 1016.3.
DAM 788
TOP 1010
Q_E Q_T

EL	H _s	Q _s	H _o	Q _g	Q _E	Q _T
1015		0				0
1016		400				400
1016.5		730				730
1017		1130	0.5	381		1510
1019		3190	2.5	4263		7450
1020		4460	3.5	7062	590	12110

TOP OF GRAVITY DAM 1016.3

EL	A	S	D
981	0	0	0
1015	218	4454	0
1016.5	228	4791.3	730
1017	232	4907	1510
1019	245	5383	7450
1020	251	5627.5	12110

TAMS

Job No. 1551-11

Sheet 4 of 4

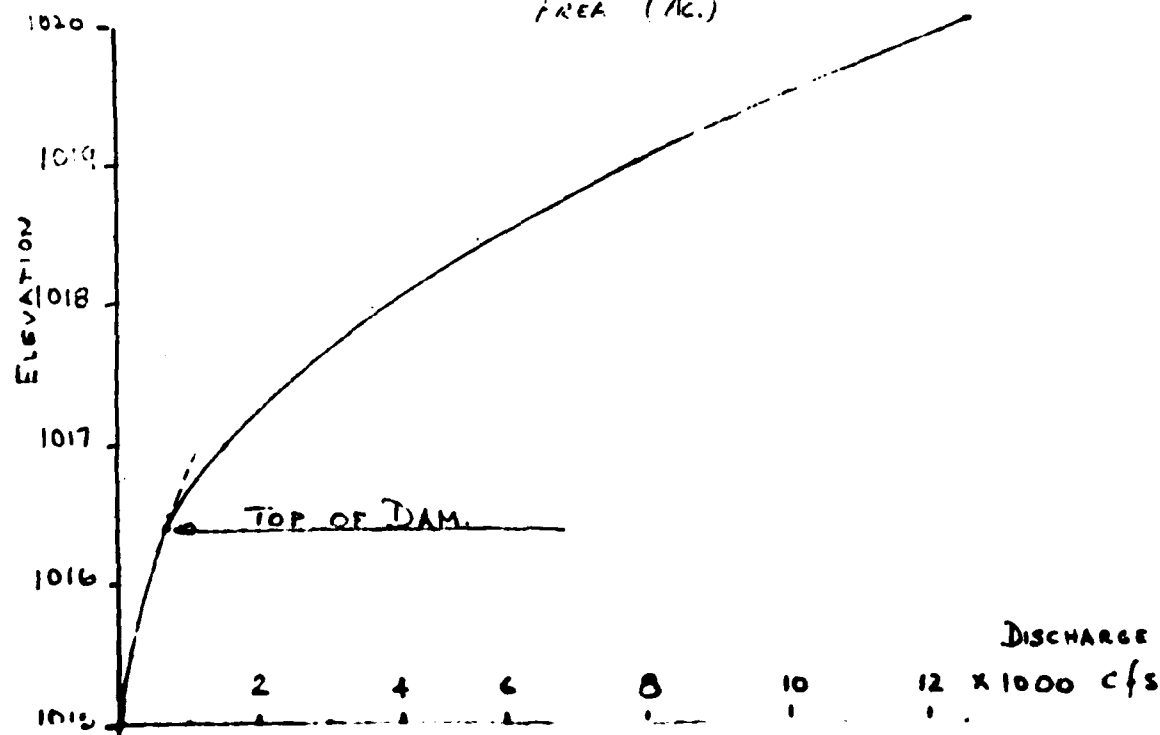
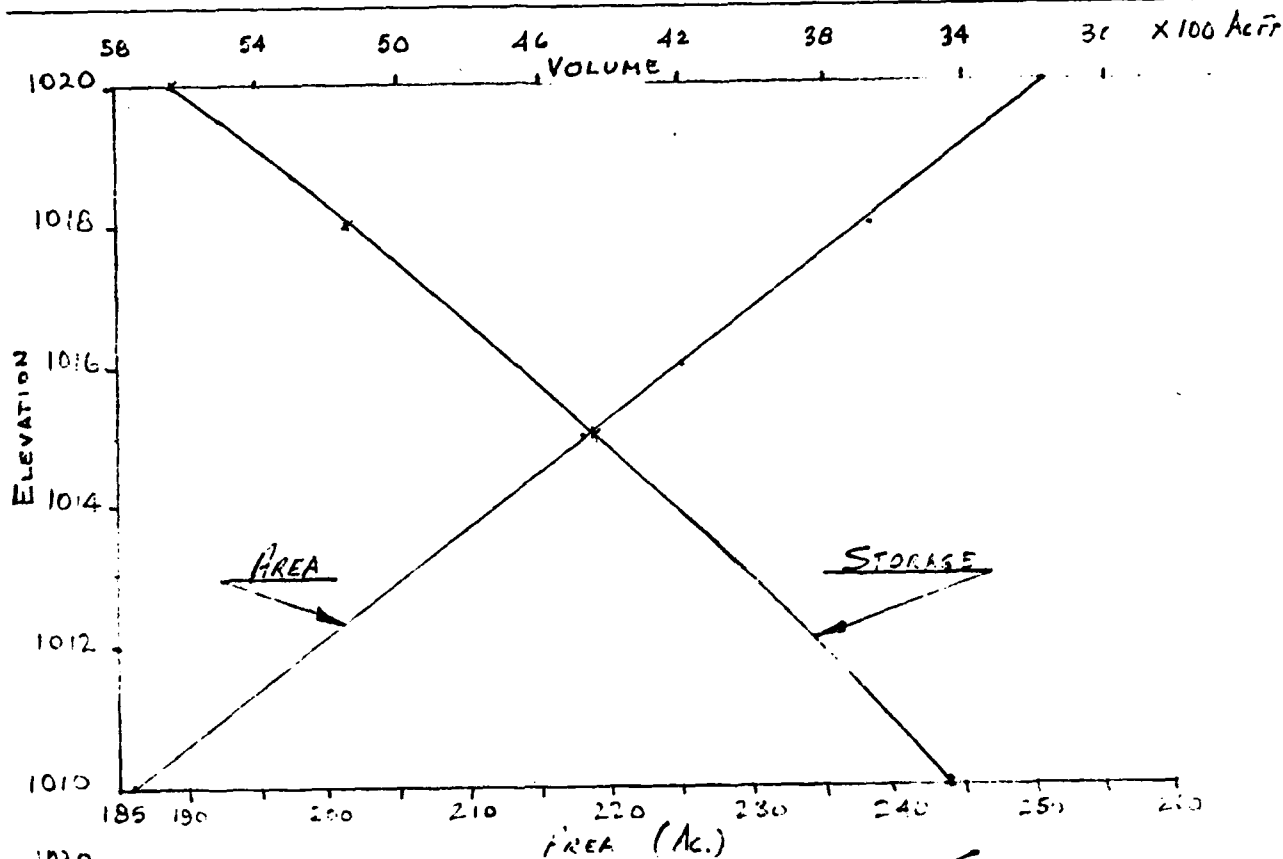
Project LAKE WELCH PHASE 1 INSPECTION

Date MAY 14 1980

Subject HYDROLOGIC/HYDRAULIC COMPUTATION

By DLC

Ch'k. by _____



53
00
10
99
505
3160
506
8210
520
8270
540
8100
500

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	1
ROUTE HYDROGRAPH TO	2
ROUTE HYDROGRAPH TO	3
ROUTE HYDROGRAPH TO	4
ROUTE HYDROGRAPH TO	5
ROUTE HYDROGRAPH TO	6
END OF NETWORK	

FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION JULY 1978
 LAST MODIFICATION 26 FEB 79

RUN DATE= 8C/05/21.
 TIME= 19.02.01.

PHASE 1 INSPECTION AND SAFETY EVALUATION OF LAKE WELCH DAM 1551-11
 SPILLWAY ADEQUACY TESTS USING PROBABLE MAXIMUM FLOOD
 TAMS ENGINEERS & ARCHITECTS

JOB SPECIFICATION											
NQ	MNR	DAY	MIN	DAY	HR	MIN	MTRC	IPLT	IPRT	INSTAN	
100	0	30	0	0	0	0	0	0	0	0	
JOPER 5											
LROPT TRACE											
5											
0											

MULTI-PLAN ANALYSES TO BE PERFORMED
 NPLAN= 1 NRTIO= 2 LRTIO= 1

RTIOS= 1.00 .50

SUB-AREA RUNOFF COMPUTATION

UNIT HYDROGRAPH AND INFLOW HYDROGRAPH COMPUTATION

STAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	0	0	0

HYDROGRAPH DATA

INTDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	2.87	0.00	2.87	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	24.50	106.10	122.40	134.70	151.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STBKR	DLTKR	RTIOL	ERAIN	STBKS	RIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	2.00	.05	0.00	.15

UNIT HYDROGRAPH DATA

TP= 3.02 CP= .63 NTA= 0

RECESSION DATA

STARTQ= -1.00 GRCSN= -.05 RTIOR= 3.00
 APPROXIMATE LAG COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 6.90 AND R= 5.43 INTERVALS

UNIT HYDROGRAPH 33 END-OF-PERIOD ORIGINATES, LAG= 3.00 HOURS, CP= .63 VOL= 1.00									
24.	89.	176.	270.	346.	387.	386.	342.	236.	
196.	163.	130.	113.	94.	78.	65.	54.	45.	
31.	26.	21.	18.	15.	12.	10.	8.	7.	
5.	4.	3.							

END-OF-PERIOD FLOW

FLOW									
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.

STORAGE									
4454.	4454.	4454.	4454.	4454.	4454.	4454.	4454.	4454.	4454.
4455.	4455.	4455.	4455.	4455.	4455.	4455.	4455.	4455.	4455.
4456.	4456.	4456.	4456.	4456.	4456.	4456.	4456.	4456.	4456.
4457.	4457.	4457.	4457.	4457.	4457.	4457.	4457.	4457.	4457.
4458.	4458.	4458.	4458.	4458.	4458.	4458.	4458.	4458.	4458.
4459.	4459.	4459.	4459.	4459.	4459.	4459.	4459.	4459.	4459.
4460.	4460.	4460.	4460.	4460.	4460.	4460.	4460.	4460.	4460.
4461.	4461.	4461.	4461.	4461.	4461.	4461.	4461.	4461.	4461.
4462.	4462.	4462.	4462.	4462.	4462.	4462.	4462.	4462.	4462.

STAGE									
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0
1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0	1015.0

PEAK OUTFLOW IS 2724. AT TIME 44.00 HOURS

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
2724.	2106.	772.	385.	38476.
77.	60.	22.	11.	1090.
CFS	INCHES	MM	AC-FT	THOUS CU M
173.37	254.32	263.97	263.97	1590.
1044.	1532.	1590.	1590.	1961.
1288.	1889.	1961.	1961.	

NORMAL DEPTH CHANNEL ROUTING

[illegible]

CHANNEL ROUTING STN 4+00 TO 26+00

ISTAQ	ICOMP	IECON	ITAPE	JPLI	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	0	0	0
ROUTING DATA								
QLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR	
0.0	0.00	1	1	0	0		0	
NTPS								
1	0	LAG	ANSKK	X	TSK	STORA	ISPRAT	
		0	0.000	0.000	0.000	0.	0	

ACRVAL DEPTH ZHANNFL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0400	.0400	.0400	900.0	960.0	2200.	.03200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

1126.00	960.00	1180.00	940.00	1250.00	920.00	1370.00	917.00	1440.00	917.00
2000.00	900.00	2090.00	920.00	2150.00	940.00				

STORAGE	0.00	0.43	37.71	84.86	150.86	235.72	346.99	480.45	618.24	759.30
	903.64	1051.25	1202.14	1356.20	1512.16	1669.64	1828.62	1989.12	2151.13	2314.65

OUTFLOW	0.00	163.10	10687.04	31508.97	67858.48	123035.62	192777.64	316989.76	477106.25	664032.53
£76793.21	1114693.07	3377325.42	1666521.17	1984701.22	2326227.66	2690629.97	3077507.77	3486516.94	3917359.43	

[illegible]

0.00	1683.10	10687.04	31508.97	67858.48	123035.62	192777.64	316989.76	477106.25	664032.53
876793.21	1114693.07	1377825.42	1666524.17	1984701.22	236227.66	2690629.97	3077507.77	3486516.94	3917359.43

STATION 4, PLAN 1, RTIO 1

OUTFLOW

[illegible]

TOR

[illegible]

AO-AU91 279

NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION ALBANY F/G 13/13
NATIONAL DAM SAFETY PROGRAM, LAKE WELCH DAM (INVENTORY NUMBER N--ETC(1))
SEP 80 E O'BRIEN DACW51-79-C-0001

UNCLASSIFIED

NL

2 OF 2
NO. 00000000



END
DATE
FILMED
11-80
DTIC

1000.00	480.00	8100.00	500.00
---------	--------	---------	--------

MAXIMUM STORAGE = 16.

16.

MAXIMUM STAGE IS 485.0

STATION		6. PLAN 1, RTIO 2									
		OUTFLOW									
1.	0.	0.	1.	2.	3.	4.	5.	6.	7.	8.	9.
1.	1.	1.	2.	2.	2.	2.	2.	2.	2.	2.	3.
3.	3.	4.	4.	5.	5.	5.	5.	6.	6.	7.	7.
81.	9.	12.	21.	29.	39.	51.	62.	73.	84.	80.	72.
76.	87.	93.	93.	92.	90.	87.	84.	80.	70.	70.	70.
73.	73.	71.	69.	67.	68.	69.	69.	70.	70.	70.	70.
169.	75.	78.	89.	98.	109.	122.	137.	153.	169.	181.	196.
574.	186.	205.	240.	266.	301.	347.	406.	481.	574.	686.	816.
2229.	1963.	1728.	1521.	1381.	1266.	1149.	1026.	918.	816.	728.	648.

STOR											
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
2.	3.	4.	6.	7.	8.	9.	9.	9.	8.	8.	8.
6.	7.	7.	6.	6.	5.	5.	4.	4.	3.	3.	3.

STAGE											
480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0	480.0
480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2
480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2
480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2	480.2
480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4	480.4
481.3	481.6	482.3	483.2	483.5	483.6	483.7	483.7	483.7	483.7	483.7	483.6
483.5	483.4	483.3	483.2	483.2	482.9	482.7	482.4	482.1	481.9	481.9	481.9

PEAK		6-HOUR		24-HOUR		72-HOUR		TOTAL VOLUME	
CFS	2730.	2105.	767.	382.	382.	382.	382.	38199.	38199.
CMS	77.	60.	22.	11.	11.	11.	11.	1081.	1081.
INCHES	6.82	9.94	10.31	10.31	10.31	10.31	10.31	262.00	262.00
MM	173.27	252.53	262.00	262.00	262.00	262.00	262.00	1578.	1578.
AC-FT	1044.	1521.	1578.	1578.	1578.	1578.	1578.	1946.	1946.
THOUS CU M	1287.	1876.	1946.	1946.	1946.	1946.	1946.	1946.	1946.

MAXIMUM STORAGE = 9.

MAXIMUM STAGE IS 483.7

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	RATIOS APPLIED TO FLOWS		
			PLAN	RATIO 1	RATIO 2
				1.00	.50
HYDROGRAPH AT					
	1	2.87	1	6169.	3085.
	(7.43)	(174.70)	(87.35)
ROUTED TO					
	2	2.87	1	5711.	2724.
	(7.43)	(161.72)	(77.15)
ROUTED TO					
	3	2.87	1	5705.	2732.
	(7.43)	(161.54)	(77.36)
ROUTED TO					
	4	2.87	1	5702.	2738.
	(7.43)	(161.47)	(77.53)
ROUTED TO					
	5	2.87	1	5708.	2738.
	(7.43)	(161.62)	(77.54)
ROUTED TO					
	6	2.87	1	5710.	2730.
	(7.43)	(161.69)	(77.29)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1015.00	1015.00	1016.30	
STORAGE	4454.	4454.	4746.	
OUTFLOW	0.	0.	633.	

RATIO OF PHF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1018.41	2.11	5244.	5711.	11.30	43.30	0.00
.50	1017.41	1.11	5004.	2724.	9.50	44.00	0.00

PLAN 1		STATION 3	
RATIO	MAXIMUM FLOW/CFS	MAXIMUM STAGE/FT	TIME HOURS
1.00	5705.	977.1	43.50
.50	2732.	975.3	44.00

PLAN 1		STATION 4	
RATIO	MAXIMUM FLOW/CFS	MAXIMUM STAGE/FT	TIME HOURS
1.00	5702.	904.6	43.30
.50	2738.	903.5	44.00

PLAN 1		STATION 5	
RATIO	MAXIMUM FLOW/CFS	MAXIMUM STAGE/FT	TIME HOURS
1.00	5708.	647.0	43.50
.50	2738.	645.1	44.00

PLAN 1		STATION 6	
RATIO	MAXIMUM FLOW/CFS	MAXIMUM STAGE/FT	TIME HOURS
1.00	5710.	485.0	43.50
.50	2730.	483.7	44.00

STABILITY ANALYSIS

APPENDIX E

Job No. 1511

TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORK

Sheet 1 of 11

Project PHASE I DAM INSPECTION

Date 6/1/80

Subject DAM STABILITY ANALYSIS

By JP

LAKE WELCH

Chk. by

Assumptions:

- 1) The unit weight of concrete is assumed to be 145 lbs/cu. ft.
- 2) Ice load of 5000 lbs/sq ft acting about 1 foot from top of dam. (according to Corps of Engineers criteria)
- 3) Angle of internal resistance of rock is assumed to be 45° based on visual examinations of the exposed rock at downstream toe and its bedding planes.
- a) Dam site is seismic zone 2

LOADING CONDITIONS

- Case I Normal loading; Lake level at spillway crest El 1015.0 no ice load.
- Case II Normal loading; Lake level at spillway crest El 1015.0, with ice load.
- Case III Unusual loading; Lake level at $\frac{1}{2}$ P.I.F.
- Case IV Extreme loading; Lake level at P.I.F.
- Case V Unusual loading; Lake level at spillway crest and earthquake forces of 0.05g.

Job No. 1511TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
NEW YORKSheet 2 of 11Project Phase 1 InspectionDate 6/1/82Subject Dam Stability AnalysisBy JP

Ch'k. by _____

STABILITY CRITERIA:

The stability criteria against overturning and sliding were evaluated as follows.

Overturning - Stability is considered adequate if the resultant of all forces falls within the middle third of the base under the normal loading condition and within middle half of the base under the unusual and extreme loading conditions.

Sliding - Stability along the base of the structure is evaluated using the friction factor of safety (FFS) which is equal to $V \tan \phi / H$, where V is the sum of vertical forces acting on the base, H is the sum of all horizontal forces and $\tan \phi$ is Friction Factor. the stability with respect to sliding is considered adequate if the FFS exceeds 1.50 under normal loading conditions, 1.25 under unusual loading conditions and 1.1 under extreme loading conditions.

Job No. 1511TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
NEW YORKSheet 3 of 11Project Phase 1 Dam InspectionDate 6/1/82

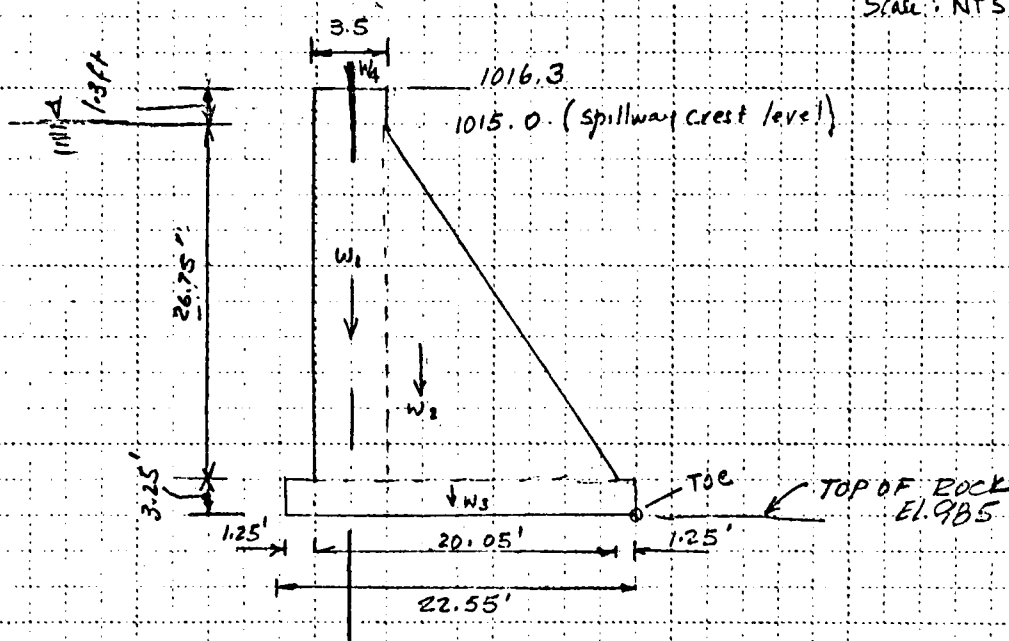
Subject _____

By JP

Ch'k. by _____

DEAD LOADS

Scale: NTS

 $\Sigma M @ Toe$

$$W_1 = 0.145 \times 3.5 \times 28.05 = 14.23 \times 19.55 = 278.2$$

$$W_2 = 0.145 \times \frac{1}{2} \times 16.55 \times 26.75 = 32.09 \times 12.28 = 394.1$$

$$W_3 = 0.145 \times 22.55 \times 22.55 = 10.63 \times 11.28 = 119.9$$

$$F_v = 56.95 \quad M_R = 792.2 \text{ KF} \quad \bar{x} = 13.91'$$

$$14.23 \times 17.28 = 245.9$$

$$32.09 \times 12.17 = 390.5$$

$$10.63 \times 1.63 = 17.3$$

$$F_v = 56.95 \quad 653.7 \quad \bar{y} = 11.47'$$

 $\Sigma M_R @ Toe$ due to Rock Bolt

$$W_4 = \frac{50000 \#}{10 \text{ LF}} = 5000 \#/\text{LF}$$

$$F_v = 5 \text{ K}$$

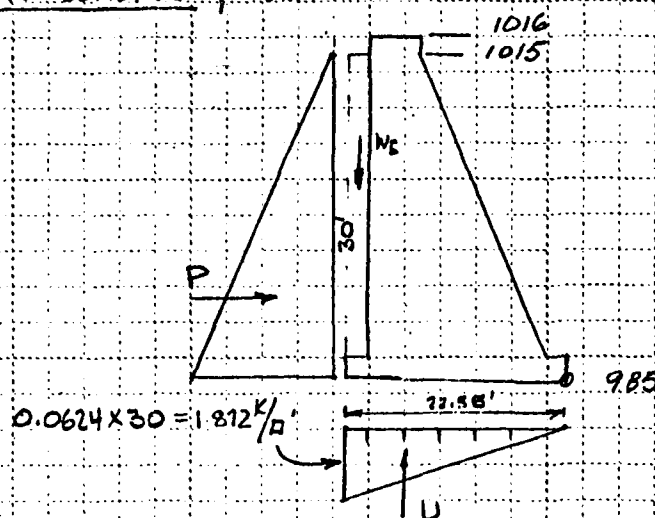
$$M_R = 5 \times 19.55 = 97.75 \text{ KF}$$

Job No. 1511TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
NEW YORKSheet 4 of 11Project PHASE 1 DAM INSPECTIONDate 6/1/82

Subject _____

By JP

Ch'k. by _____

HYDROSTATIC FORCESa. NORMAL LOADING ; WL at El. 1015ΣM @ Toe

$$P = \frac{1}{2} \times 1.872 \times 30$$

$$= 28.08 \times 10 = 280.8 \text{ k}$$

$$U = \frac{1}{2} \times 1.872 \times 22.55$$

$$= -21.11 \times 15.03 = 317.28 \text{ k}$$

$$W_s = 0.0624 \times 125 \times 26.75 = 2.09 \times 21.93 =$$

$$45.83 \text{ k}$$

$$598.08 \text{ k}$$

$$F_v = -19.02 \text{ k}$$

$$F_H = 28.08 \text{ k}$$

$$N_R = 45.83 \text{ k}$$

$$N_O = 598.08 \text{ k}$$

Job No. 1511

TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
NEW YORK

Sheet 5 of 11

Project PHASE 1 DAM INSPECTION

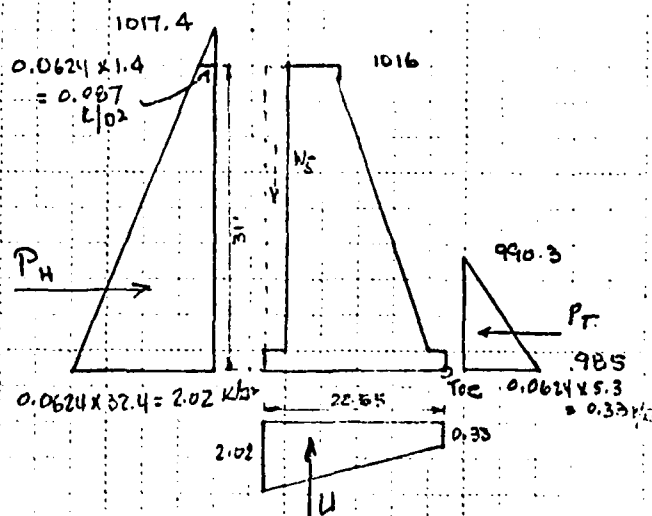
Date 12/1/50

Subject

By J.P.

Chk. by

Maximum loading: $\frac{1}{2}$ PMF WL @ El. 1017.4; tail water
El. 990.3

 $\Sigma M @ Toe$

$$P_H = \left[\frac{0.087 + 2.02}{2} \right] 31 = 32.65 \times 10.76 = 351.3$$

$$P_T = \left(\frac{1}{2} \times 0.33 \times 5.3 \right) 0.6 = 0.52 \times 1.76 = 0.9$$

60% tail water pressure

$$U = \left(\frac{0.33 + 2.02}{2} \right) 22.55 = 26.50 \times 13.98 = 370.47$$

$$W_S = 0.0624 \times 1.25 \times 27.75 = 2.16 \times 21.93$$

47.37

$$\begin{aligned} F_V &= -24.34 \uparrow \\ F_H &= 32.13 \rightarrow \\ M_R &= 48.27 \text{ KF} \\ M_O &= 721.77 \text{ KF} \end{aligned}$$

Job No. 1511

TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
NEW YORK

Sheet 6 of 11

Project PHASE I DAM INSPECTION

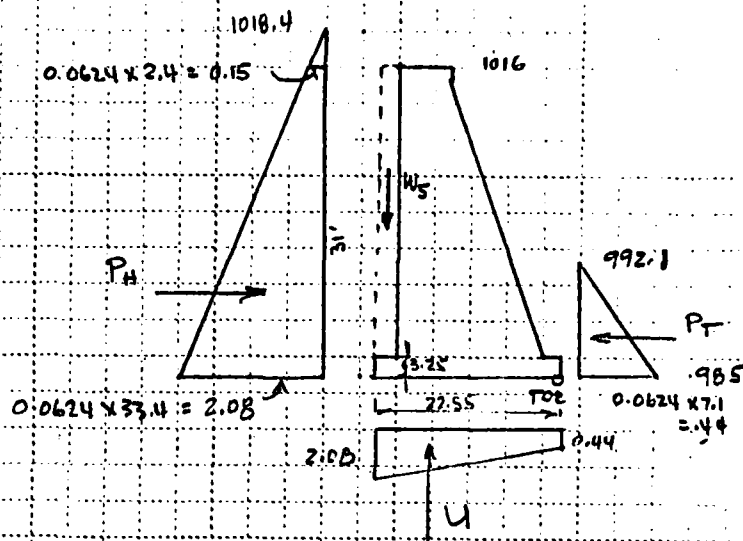
Date 6/1/80

Subject

By JP

Ch'k. by

Maximum loading: P.M.E. WL @ 1018.4; tailwater El. 992.1

 $\Sigma M @ Toe$

$$P_H = \left[\frac{0.15 + 2.08}{2} \right] 31 = 34.57 \times 11.0 = 380.27$$

$$U = \left[\frac{0.44 + 2.00}{2} \right] 22.55 = 28.41 \times 13.72 = 389.79$$

$$P_T = \frac{1}{2} [0.44 \times 7.1] 0.6 = 0.93 \times 2.37 = 2.20$$

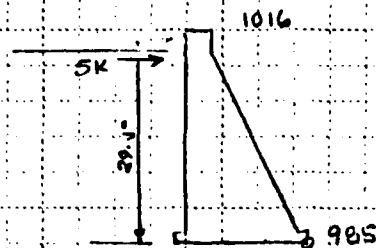
$$W_5 = 0.0624 \times 1.25 \times 27.75 = 2.14 \times 21.93 = 47.37$$

$$\begin{aligned} F_V &= -26.25^K \uparrow \\ F_H &= 33.64^K \rightarrow \\ M_D &= 49.57^{KF} \\ W_0 &= 770.06^{KF} \end{aligned}$$

Job No. 1511TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
NEW YORKSheet 7 of 11Project PHASE I INSPECTION -Date 6/1/62Subject DAM STABILITYBy JPCh'k. by ICE LOAD

EM @ Toe

$$50 \times 29.5 = 1475.0 \text{ KF}$$

CASE I NORMAL LOADING - WITHOUT ICE

	F_v	F_H	M_R	M_o
Dead load	56.95	0.0	792.2	0
Hydrostatic	-19.02	28.08	45.83	598.08
Rock Bolt	5.00	0	97.75	0
	<u>42.93</u>	<u>28.08</u>	<u>935.78</u>	<u>598.08</u>

$$\Sigma M = 935.78 - 598.1 = 337.68 \text{ KF}$$

$$e = \frac{22.55}{2} - \frac{337.68}{42.93} = 11.28 - 7.87 = 3.41' \text{ downstream from base } \phi$$

Resultant Location

$$\frac{337.68}{42.93} - \frac{22.55}{5} = 7.87 - 4.52 = 3.35' \text{ inside middle third. OK}$$

$$p = \frac{42.93}{22.55} \left(1 \pm \frac{6 \times 3.41}{22.55} \right) \times \frac{1000}{144} = 13 \pm 12 \quad \left\{ \begin{array}{l} 25 \text{ psi @ Toe} \\ 1 \text{ @ Heel} \\ \text{OK} \end{array} \right.$$

Friction Factor of Safety

$$FFS = \frac{42.93 \times \tan 45^\circ}{28.08} = 1.53 \quad \text{OK}$$

Job No. 1511TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
NEW YORKSheet 8 of 11Project PHASE 1 DAM INSPECTIONDate 6/1/80Subject DAM STABILITY ANALYSISBy JL

Ch'k. by _____

CASE II NORMAL LOADING WITH ICE LOAD

	F_v	F_H	M_x	M_o
Dead load	56.95	0.0	792.2	
Hydrostatic	-19.02	28.08	45.83	598.08
Rock Bolt	5.0	0	97.75	0
Ice load		5.0		147.50
	<u>42.93</u>	<u>33.08</u>	<u>935.78</u>	<u>745.58</u>

$$\Sigma M = 935.78 - 745.58 = 190.2$$

$$e = \frac{22.55}{2} - \frac{190.2}{42.93} = 11.28 - 4.43 = 6.85' \text{ downstream from base } \phi$$

$$\text{Resultant location} = \frac{190.2}{42.93} - \frac{22.55}{3} = 4.43 - 7.52 = -3.09' \text{ out Side middle third.}$$

$$p = \frac{42.93}{22.55} \left(1 + \frac{6 \times 6.85}{22.55} \right) \times \frac{1000}{144} = 13 \pm 24 \quad \begin{matrix} 37 \text{ psi @ Toe} \\ -11 \text{ psi @ Heel} \end{matrix}$$

Friction Factor of Safety

$$FFS = \frac{42.93 \times \tan 45^\circ}{33.08} = 1.30$$

For resultant to lie within middle third, the additional force the rock bolt would be subject = V

$$7.52 = \frac{190.2 + 19.55V}{42.93 + V}$$

$$322.83 + 7.52V = 190.2 + 19.55V$$

$$V = 11.0 \text{ Kips}$$

$$50.0 + 11.0 = 61.0 \text{ Kips} \left(\begin{matrix} \text{Max Ultimate} \\ \text{load} \approx 75 \text{ Kips} \end{matrix} \right)$$

OK.

Job No. 1511TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS
NEW YORKSheet 9 of 11Project PHASE I DAM INSPECTIONDate 6/1/50Subject DAM STABILITY ANALYSISBy J.P.

Ch'k. by _____

Case III $\frac{1}{2}$ PMF

	F_v	F_H	M_R	M_D
Dead load :	56.95	0.0	792.2	0
Hydrostatic :	-24.34	32.13	48.27	721.77
Rock bolt :	5.0	0	97.75	0
	<u>37.61</u>	<u>32.13</u>	<u>938.22</u>	<u>721.77</u>

$$EM = 938.22 - 721.77 = 216.45$$

$$e = \frac{22.55}{2} - \frac{216.45}{37.61} = 11.28 - 5.76 = 5.52' \text{ downstream from base } \&$$

Resultant Location $\frac{216.45}{37.61} - \frac{22.55}{3} = 5.76 - 7.52 = -1.76' \text{ out side middle third.}$

$$p = \frac{37.61}{22.55} \left(1 \pm \frac{6 \times 5.52}{22.55} \right) \times \frac{1000}{144} = 12 \pm 17$$

29 psi @ Toe
-5 psi @ heel.
OK

Friction Factor of Safety

$$FFS = \frac{37.61 \tan 45^\circ}{32.13} = 1.17$$

CASE IV PMF

	F_v	F_H	M_R	M_D
Dead load :	56.95	0.0	792.2	0
Hydrostatic :	-26.25	33.64	49.57	770.06
Rock bolt :	5.0	0	97.75	0
	<u>35.70</u>	<u>33.64</u>	<u>939.52</u>	<u>770.06</u>

$$EM = 939.52 - 770.06 = 169.46 \text{ K.F.}$$

$$e = \frac{22.55}{2} - \frac{169.46}{35.70} = 11.28 - 4.75 = 6.53' \text{ downstream from base } \&$$

Job No. 1511TIPPETTS-ABBETT-McCARTHY-STRATTON
ENGINEERS AND ARCHITECTS NEW YORKSheet 10 of 11Project PHASE I DAM INSPECTIONDate 6/1/80Subject DAM STABILITY ANALYSISBy JP

Ch'k. by

PMF - Continued.

$$\text{Resultant Location} = \frac{169.46}{35.70} - \frac{22.55}{3} = 4.75 - 7.52 = -2.77' \text{ out side middle third}$$

$$p = \frac{35.70}{22.55} \left[1 \pm \frac{6 \times 6.53}{22.55} \right] \times \frac{1000}{144} = 11 \pm 19 \quad \begin{array}{l} 30 \text{ psi @ Toe} \\ -8 \text{ psi @ heel} \end{array}$$

FRICTION FACTOR OF SAFETY

$$FFS = \frac{35.70 \tan 45^\circ}{33.64} = 1.06$$

CASE V ; Normal loading with Earthquake. Reservoir level at E.I. 1015

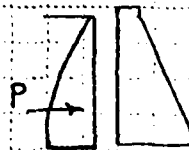
$$\text{Zone 2} = 0.05$$

$$\text{Zangers Method ; } c = 0.726 \text{ when } \theta = 0^\circ$$

(1) Hydrodynamic Forces :

$$P = 0.726 \times 0.05 \times 0.0624 \times 30^2 = 2.03 \text{ Kips}$$

$$M_p = 2.03 \{ 0.4 \times 30 \} = 24.36 \text{ K-F}$$



(2) Dynamic Forces

$$W_D = 0.05(56.95) = 2.85 \text{ K}$$

$$M_{WD} = 2.85 \times 7 = 2.85 \times 11.47 = 32.69 \text{ K-F}$$

Job No. 1511 TIPPETTS-ABBETT-McCARTHY-STRATTON
 ENGINEERS AND ARCHITECTS NEW YORK
 Project PHASE I DAM INSPECTION
 Subject DAM STABILITY ANALYSIS

Sheet 11 of 11
 Date 6/1/60
 By JP
 Ch'k. by _____

	F_v	F_H	M_R	M_o
Dead Load	56.95	0.0	792.2	
Hydrostatic	-19.02	28.08	45.83	598.08
Rock Bolt	5.0	0	97.75	0
Earthquake } Hydrodynamic		2.03		24.36
Dynamic		2.85		32.69
	42.93	32.96	935.78	655.13

$$EM = 935.78 - 655.13 = 280.65$$

Resultant Location

$$\frac{280.65}{42.93} - \frac{22.55}{3} = 6.54 - 7.52 = -0.98' \text{ outside middle third}$$

$$e = \frac{22.55}{2} - 6.54 = 11.28 - 6.54 = 4.74' \text{ downstream from base } \phi$$

$$p = \frac{42.93}{22.55} \left(1 \pm \frac{6 \times 4.74}{22.55} \right) \times \frac{1000}{144} = 13 \pm 17 \quad \begin{matrix} 30 \text{ psi @ Toe} \\ -4 \text{ psi @ Heel} \end{matrix}$$

FRICTION FACTOR OF SAFETY

$$FFS = \frac{42.93 \tan 45^\circ}{32.96} = 1.30$$

OTHER DATA:

- (1) AVAILABLE STABILITY ANALYSIS
- (2) CORRESPONDENCE BETWEEN OWNER
AND ENGINEER DURING 1978-79
REPAIRS

April 3, 1978

3308-001-1

Stability Analysis of the
Lake Welch Gravity Dam

The Lake Welch Dam was analyzed for both sliding and overturning stability. Three conditions of loading were considered:

- Case I Normal condition of dead hydrostatic forces, including uplift.
- Case II Extreme condition of normal loading plus ice forces of 3,000 pounds per lineal foot.
- Case III Extreme condition of normal loading plus earthquake forces of 0.05g.

The analysis showed that the ratio of the horizontal forces tending to cause sliding to the vertical forces are, for the three conditions respectively, 0.78, 0.86 and 0.97. While there are no codes, or universally accepted standards, mandating the design of gravity dams, these values are somewhat higher than modern practice would dictate.

The analysis showed further that the corresponding ratios of moments resisting overturning to the moments tending to cause overturning are 1.36, 1.18 and 1.18. These values are lower than considered prudent in modern practice.

These figures indicate that, while not in accordance with today's thinking, the dam is not approaching the point of incipient failure from either sliding or overturning. The factors found for Case I are conservative as the uplift forces applied in the analysis were determined in an accepted and conservative manner. Effects of ice in Case II can be mitigated to any degree desired by drawing down the lake in winter, either fully or partially. Regarding Case III, there has been little seismic activity in this area.

MAIN

Client Falander Interstate Park Commission Job No. 3308-1 Sheet 1 of 16
 Subject Lake Walsh Dam Repairs By P.P.C. Inc. Date 2/31/72
Dam Stability Analysis Chd. _____ Rev. _____

Loading Combinations - Dam in Present Condition

Case I (Normal)	Dead Load & Hydrostatic	
Case II (Extreme)	" " "	{ Seismic
Case III (Extreme)	" " "	{ Ice

Loading Combination - Reinforcement Added

Case IV (Normal)	Case I & Reinforcement
Case V (Extreme)	Case II & " "
Case VI (Extreme)	Case III & " "

Criteria for Analysis Results

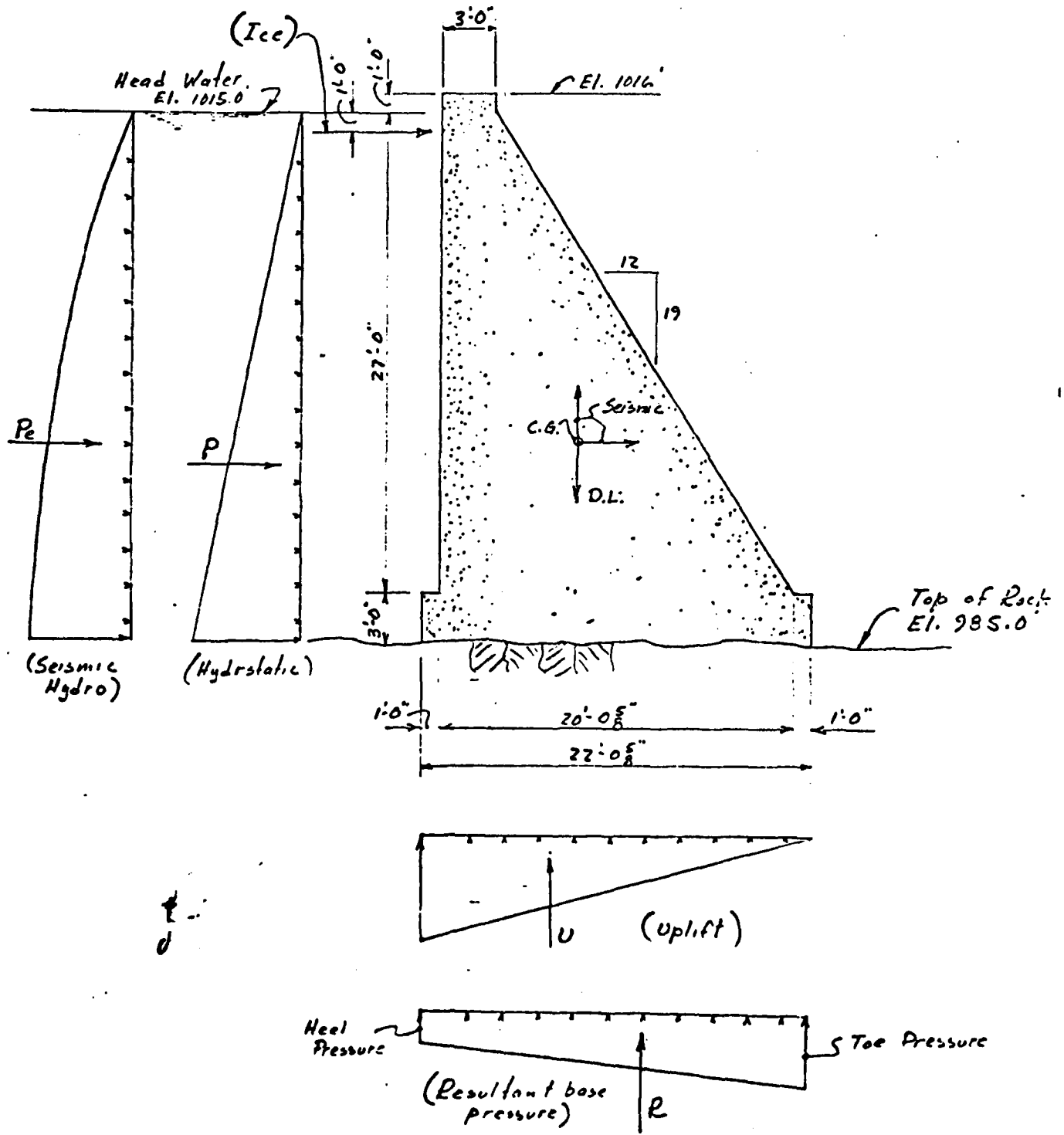
	Normal Operation	Extreme Operation
Heel or Toe Stress (Compression)	$\leq 500 \text{ PSI}$	$\leq 750 \text{ PSI}$
Heel or Toe Stress (Tension)	None	$\leq 20 \text{ PSI}$
Sliding Coefficient (f)	$\leq .70$	$\leq .75$
Overturning $\left(\frac{M_R}{M_o} \right)$	≥ 1.50	≥ 1.25

APR 7 1978

ENGINEERING
P. I. P. C.

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 2 of 16
 Subject Lake Umbagog Dam Repair By P. J. Williams Date 3/13/78
Dam Stability Analysis C.C. _____ Rev. _____

Forces acting on dam & Concrete Outline



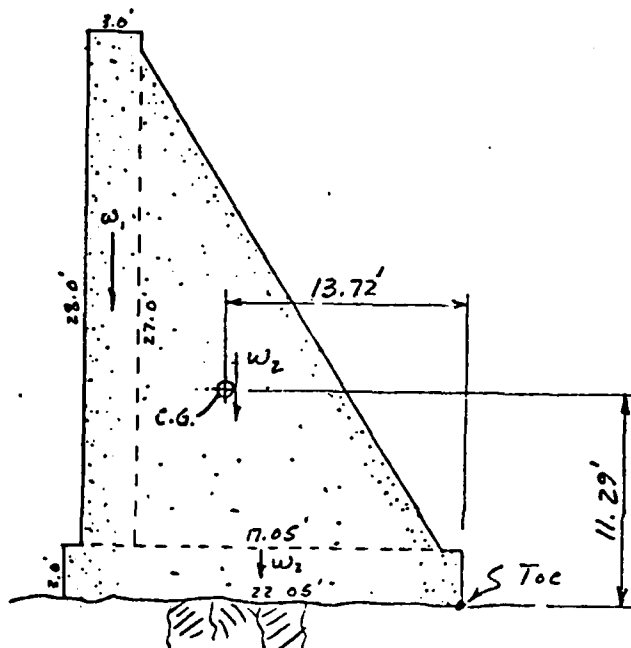
TYPICAL DAM CROSS SECTION

1000000

Client Palm Beach Interstate Park Commission Job No. 3308-1 Sheet 3 of 16
 Subject Lake Welch Dam Repairs By R. P. Lane Date 3/13/78
Dam Stability Analysis Ckd. _____ Rev. _____

Dead Loads

Concrete weight = 145 lb/ft^3



$\Sigma M @ \text{Toe}$

$$w_1 = .145 \times 3.0 \times 28.0 = 12.18 \text{ ft}^2 \times 19.55 = 238.1 \text{ ft-k}$$

$$w_2 = \frac{1}{2} \times .145 \times 17.05 \times 27.0 = 33.38 \text{ ft}^2 \times 12.37 = 412.9 \text{ ft-k}$$

$$w_3 = .145 \times 22.05 \times 3.0 = 9.57 \text{ ft}^2 \times 11.025 = 105.7 \text{ ft-k}$$

$$F_v = 55.15 \text{ k} \quad M_R = 756.7 \text{ ft-k}$$

$$e_h = \frac{756.7}{55.15} = 13.72'$$

$\frac{M}{F}$

$$\begin{array}{rcl} 12.18 & \times & 17.0 & = & 207.1 \\ 33.38 & \times & 12.0 & = & 400.6 \\ 9.57 & \times & 1.5 & = & 14.3 \\ \hline 55.15 & & & & 622.4 \end{array}$$

$$e_v = \frac{622.4}{55.15} = 11.29'$$

Summary

$$F_v = 55.15 \text{ k}$$

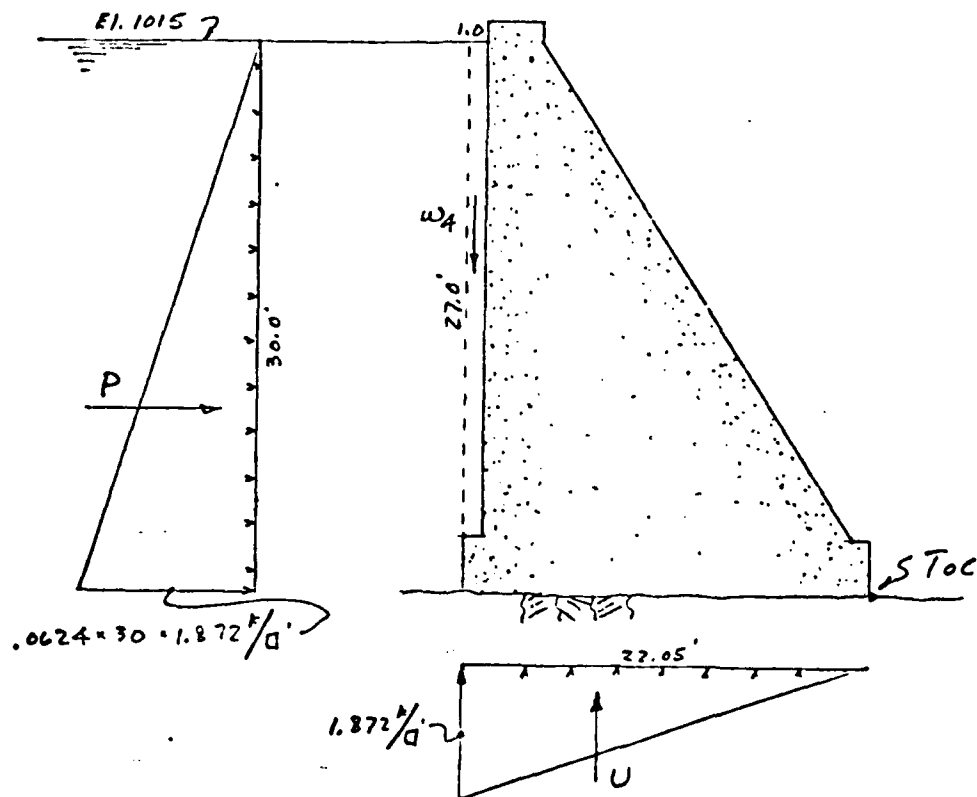
$$M_R = 756.7 \text{ ft-k}$$

MAIN

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 4 of 16
 Subject Lake Watch Dam Repairs By P. P. Palmer Date 3/13/78
Dam Stability Analysis Ckd. ● Rev.

Hydrostatic Forces

Weight of Water $\cdot 62.4 \text{ lb/ft}^3$



$\Sigma M @ T_{oc}$

$$\begin{aligned} P &= \frac{1}{2} \times 1.872 \times 30.0 = 28.08 \text{ K} \times 10.00 = 280.8 \text{ K} \\ U &= \frac{1}{2} \times 1.872 \times 22.05 = -20.64 \text{ K} \times 14.70 = 303.4 \text{ K} \\ W_1 &= .0624 \times 1.0 \times 27.0 = 1.68 \text{ K} \times 21.55 = 36.3 \text{ K} \\ &\quad -18.96 \quad \quad \quad 584.2 \end{aligned}$$

Summary

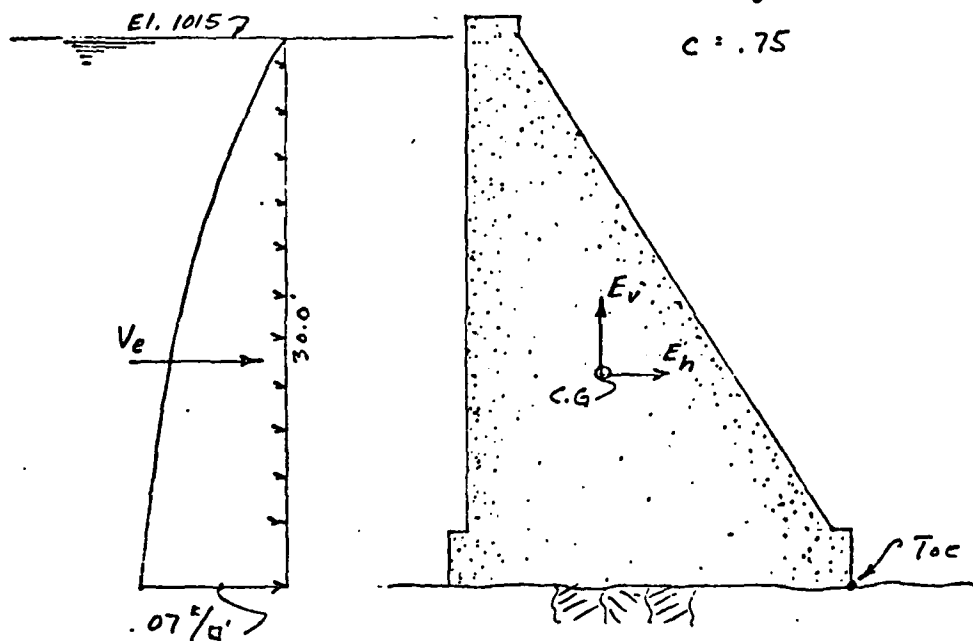
$$\begin{aligned} F_v &= -18.96 \text{ K} \\ F_H &= 28.08 \text{ K} \\ M_R &= 36.3 \text{ K} \\ M_o &= 584.2 \text{ K} \end{aligned}$$

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 5 of 16
 Subject Lake Welch Dam Repair By W.D. Palmer Date 3/14/78
Dam Stability Analysis Chd. _____ Rev. _____

Seismic Forces

$$\lambda = \frac{a}{g} = .05$$

$$C = .75$$



$$P_e = .15 \times .05 \times .0624 \times 30.0 = .07 \text{ k/ft}$$

$\Sigma M @ \text{Toe}$

$$V_e = .726 \times .07 \times 30.0 = 1.53 \text{ k}$$

$$M_e = .299 \times .07 \times 30.0^2 = 18.8 \text{ k}$$

$$E_h = .05 \times 55.15 = 2.76 \text{ k} \times 11.29 = 31.2$$

$$F_H = 4.29$$

$$E_v = .05 \times 55.15 = F_v = 2.76 \text{ k} \times 13.72$$

$$M_o = \frac{37.9}{87.9 \text{ k}}$$

Summary

$$F_v = -2.76 \text{ k}$$

$$F_H = 4.29 \text{ k}$$

$$M_o = 87.9 \text{ k}$$

(MAIN)

Client Palm Beach Interstate Park Commission Job No. 3308-1 Sheet 6 of 16

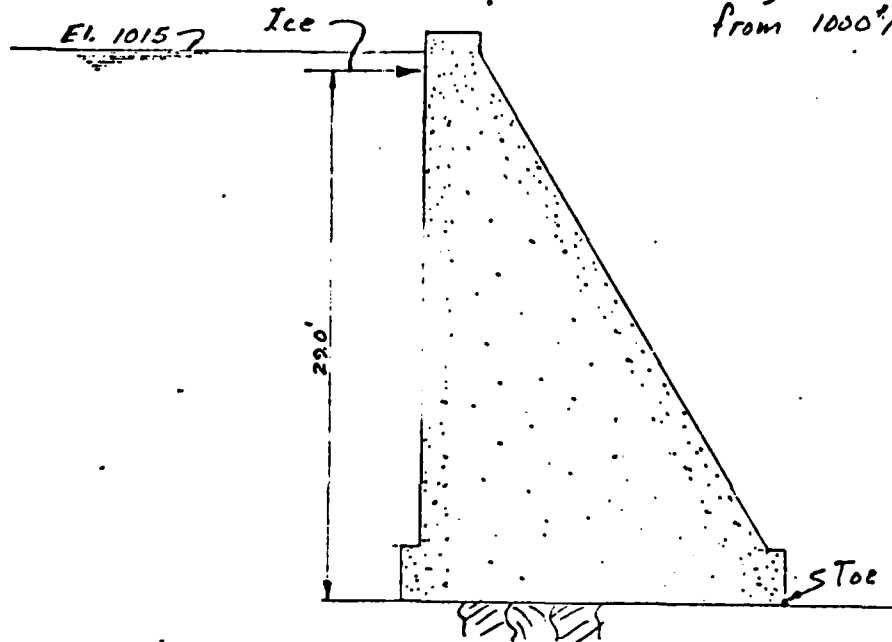
Subject Lake Welch Dam Repairs By R.L. Palmer Date 3/12/78

Dam Stability Analysis Ckd. _____ Rev. _____

Ice Forces

Ice Pressures

Vary in 1000[#] increments
from 1000[#]/l.f. to 10000[#]/l.f.



ΣM@ Toe

Summary

	F_H	M_o
(a)	1' x 29.0	= 29'K
(b)	2 x 29.0	= 58'K
(c)	3 x 29.0	= 87'K
(d)	4 x 29.0	= 116'K
(e)	5 x 29.0	= 145'K
(f)	6 x 29.0	= 174'K
(g)	7 x 29.0	= 203'K
(h)	8 x 29.0	= 232'K
(i)	9 x 29.0	= 261'K
(j)	10 x 29.0	= 290'K

Client Palmdale Interstate Park Commission Job No. 3308-1 Sheet 7 of 16
 Subject Lake Hatch Dam Repair By W.D. Palmer Date 3/12/78
Dam Stability Analysis Ckd. _____ Rev. _____

Case I D.L. & Hydrostatic Forces Combined
 Normal

	F_v	F_H	M_R	M_o
D.L.	55.15	0.0	756.7	0.0
Hydrostatic	$\frac{-18.96}{36.19}$	$\frac{28.08}{28.08}$	$\frac{36.3}{793.0}$	$\frac{584.2}{584.2}$

$$\Sigma M = 793.0 - 584.2 = 208.8' \text{ @ Toe}$$

$$e = \frac{22.05}{2} - \frac{208.8}{36.19} = 5.26' \text{ downstream from base \&}$$

$$\text{Resultant Location} = \frac{208.8}{36.19} - \frac{22.05}{3} = -1.58' \text{ outside kern}$$

$$p = \frac{36.19}{22.05} \left(1 \pm \frac{6 \times 5.26}{22.05} \right) \frac{1000}{144} = 11 \pm 16 = \begin{cases} 27 \text{ PSI @ Toe} \\ -5 \text{ PSI @ Heel} \end{cases} \quad \begin{matrix} \text{OK} \\ \text{N.G.} \end{matrix}$$

$$\text{Sliding} = \frac{28.08}{36.19} = .78 > .70 \quad \text{N.G.}$$

$$\frac{M_R}{M_o} = \frac{793.0}{584.2} = 1.36 < 1.50 \quad \text{N.G.}$$

MAIN

Client Palisades Interstate Park Commission Job No. 3208-1 Sheet 8 of 16
 Subject Lake Welch Dam Repairs By D.P. Palmer Date 3/14/78
Dam Stability Analysis Ckd. _____ Rev. _____

Case II D.L., Hydrostatic & Seismic Forces Combined
 Extreme

	F_v	F_H	M_R	M_o
D.L.	55.15 ^K	0.0 ^K	756.7 ^{1K}	0.0 ^{1K}
Hydrostatic	-18.96	28.08	36.3	584.2
Seismic	-2.76	4.29	0.0	87.9
	<u>33.43</u>	<u>32.37^K</u>	<u>793.0^{1K}</u>	<u>672.1^{1K}</u>

$$EM = 793.0 - 672.1 = 120.9^{1K} \quad @ \text{ Toe}$$

$$e = \frac{22.05}{2} - \frac{120.9}{33.43} = 7.41' \text{ downstream from base } \frac{1}{2}$$

$$\text{Resultant Location} = \frac{120.9}{33.43} - \frac{22.05}{3} = -3.73' \text{ outside kern}$$

$$p = \frac{33.43}{22.05} \left(1 \pm \frac{6 \times 7.41}{22.05} \right) \frac{1000}{144} = 11 \pm 21 = \begin{cases} 32 \text{ PSI @ Toe} \\ -10 \text{ PSI @ Heel (Tension)} \end{cases}$$

OK

$$\text{Sliding} = \frac{32.37}{33.43} = .97 > .75 \quad \text{N.G.}$$

$$\frac{M_R}{M_o} = \frac{793.0}{672.1} = 1.18 < 1.25 \quad \text{N.G.}$$

(MAIN)

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 9 of 16
Subject Lake Watch Dam Repairs By R.D. R. Cline Date 3/13/78
Dam Stability Analysis Ckd. _____ Rev. _____

Case II(a) D.L., Hydrostatic & Ice (1000*/l.f.) Combined
Extreme

	F_v	F_H	M_R	M_o
D.L.	55.15 ^{1k}	0.0	756.7	0.0
Hydrostatic	-18.96	28.08	36.3	584.2
Ice (1000*/l.f.)	0.0	1.0	0.0	29.0
	<u>36.19</u>	<u>29.08</u>	<u>793.0</u>	<u>613.2</u>

$$\Sigma M = 793.0 - 613.2 = 179.8' \text{ @ Toe}$$

$$e = \frac{22.05}{2} - \frac{179.8}{36.19} = 6.06' \text{ downstream from base \&}$$

$$\text{Resultant location} = \frac{179.8}{36.19} - \frac{22.05}{3} = -2.38' \text{ outside kern}$$

$$p = \frac{36.19}{22.05} \left(1 \pm \frac{6 \times 6.06}{22.05} \right) \frac{1000}{144} = 11 \pm 19 = \begin{cases} 30 \text{ PSI @ Toe} \\ -8 \text{ PSI @ Heel} \end{cases}$$

OK
OK

$$\text{Sliding} = \frac{29.08}{36.19} = .80 > .75 \quad \text{N.G.}$$

$$\frac{M_R}{M_o} = \frac{793.0}{613.2} = 1.29 > 1.25 \quad \text{OK}$$

Client Palmerston Interstate Park Commission Job No. 3308-1 Sheet 10 of 16
 Subject Lake Welch Dam Repairs By R. D. Palmer Date 3/14/78
Dam Stability Analysis Ckd. _____ Rev. _____

Case III(b) D.L., Hydrostatic & Ice (2000#/l.f.) Combined
 Extreme

	F_v	F_H	M_R	M_o
D.L.	55.15 ^K	0.0 ^K	756.7 ^{IK}	0.0 ^{IK}
Hydrostatic	-18.96	28.08	36.3	584.2
Ice (2000#/l.f.)	0.0	2.0	0.0	58.0
	<u>36.19^K</u>	<u>30.08^K</u>	<u>793.0^{IK}</u>	<u>642.2^{IK}</u>

$$EM = 793.0 - 642.2 = 150.8^{IK} @ Toe$$

$$e = \frac{22.05}{2} - \frac{150.8}{36.19} = 6.86' \text{ downstream from base } \&$$

$$\text{Resultant location} = \frac{150.8}{36.19} - \frac{22.05}{3} = -3.18' \text{ outside kern}$$

$$p = \frac{36.19}{22.05} \left(1 \pm \frac{6 \times 6.86}{22.05} \right) \frac{1000}{144} = 11 \pm 21 = \begin{cases} 32 \text{ P.S.I. @ Toe} \\ -10 \text{ P.S.I. @ Heel} \end{cases}$$

OK

$$\text{Sliding} = \frac{30.08}{36.19} = .83 > .75 \text{ N.G.}$$

$$\frac{M_R}{M_o} = \frac{793.0}{642.2} = 1.23 < 1.25 \text{ N.G.}$$

Client Palisades Interlake Park Commission Job No. 3308-1 Sheet 11 of 16
 Subject Lake Watch Dam Repairs By PM Palisades Date 3/14/78
Dam Stability Analysis Ckd. _____ Rev. _____

Case III(c) D.L., Hydrostatic & Ice (3000"/i.f.) Combined
 Extreme

	F_v	F_H	M_R	M_o
D.L.	55.15 ^K	0.0 ^K	756.7 ^{1K}	0.0 ^{1K}
Hydrostatic	-18.96	28.08	36.3	584.2
Ice (3000"/i.f.)	0.0	3.0	0.0	87.0
	<u>36.19^K</u>	<u>31.08^K</u>	<u>793.0^{1K}</u>	<u>671.2^{1K}</u>

$$\Sigma M = 793.0 - 671.2 = 121.8 \text{ } ^{1K} @ \text{Toe}$$

$$e = \frac{22.05}{2} - \frac{121.8}{36.19} = 7.66' \text{ downstream from base \&}$$

$$\text{Resultant location} = \frac{121.8}{36.19} - \frac{22.05}{3} = -3.98' \text{ outside kern.}$$

OK

$$p = \frac{36.19}{22.05} \left(1 \pm \frac{6 \times 7.66}{22.05} \right) \frac{1000}{144} = 11 \pm 24 = \begin{cases} 35 \text{ PSI @ Toe} \\ -13 \text{ PSI @ Heel} \end{cases}$$

OK

$$\text{Sliding} = \frac{31.08}{36.19} = .86 > .75 \text{ N.G.}$$

$$\frac{M_R}{M_o} = \frac{793.0}{671.2} = 1.18 < 1.25 \text{ N.G.}$$

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MAIN

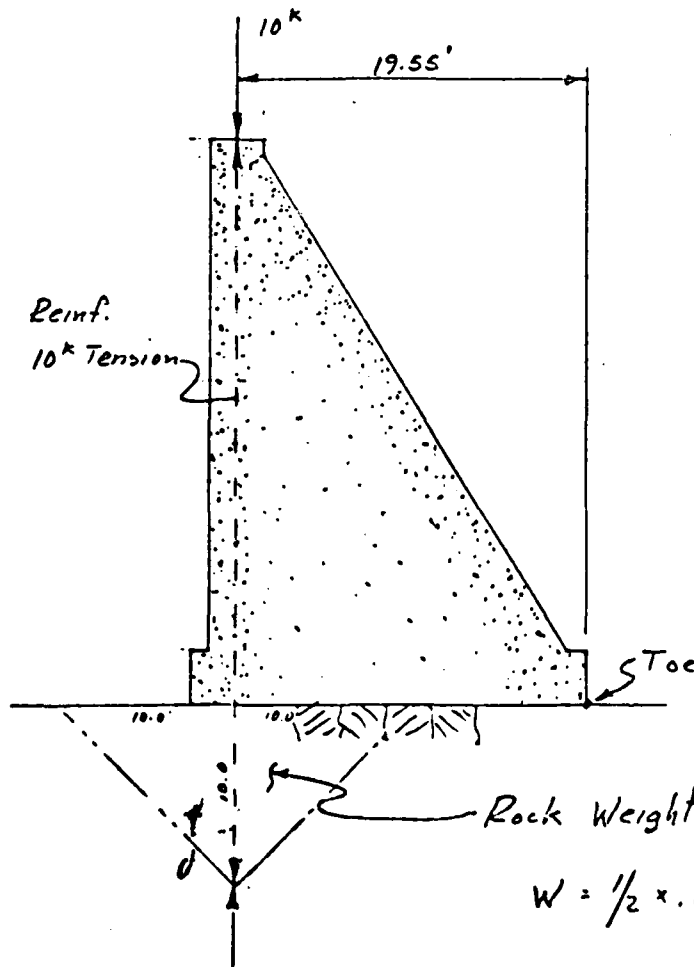
Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 12 of 16
 Subject Lake Watch Dam Repairs By P. Palmer Date 3/31/78
Dam Stability Analysis Ckd. _____ Rev. _____

Reinforcement - Williams Rock Bolt US-11-HC-SCS-200
 Max. Working Load: 74,000[#]

Design Load = $\frac{2}{3} \times 74,000 = 49,333^{\#} \pm$
 Use 50,000[#]

Bolt spacing @ 5' o.c

Load per ft = $\frac{50,000}{5} = 10,000^{\#}/\text{f.t.}$



$$M_R = 10.0 \times 19.55 = 195.5^{\text{ft-k}}$$

$$\text{Wt. of Granite Rock} = 165^{\#}/\text{ft.}^3$$

$$W = \frac{1}{2} \times 165 \times 10.0 \times 20.0 = 16.5^{\text{k}} > 10^{\text{k}} \text{ O.K.}$$

Summary

$$F_v = 10^{\text{k}}$$

$$M_R = 195.5^{\text{ft-k}}$$

(MAINTS)

Client Palmer Park Commission Job No. 3308-1 Sheet 13 of 16
Subject Lake Wicket Dam Repair By P.D. Palmer Date 3/31/78
Dam Stability Analysis Ckd. _____ Rev. _____

Case IV D.L., Hydrostatic & Reinforcement Combined
Normal (Case I & Reinf.)

	F_v	F_h	M_2	M_o
Case I	36.19 ^K	28.08 ^K	793.0 ^{ft-K}	584.2 ^{ft-K}
Reinf.	<u>10.00</u>	<u>0.0</u>	<u>195.5</u>	<u>0.0</u>
	46.19 ^K	28.08 ^K	988.5	584.2

$$\Sigma M = 988.5 - 584.2 = 404.3 \text{ @ Toe}$$

$$e = \frac{22.05}{2} - \frac{404.3}{46.19} = 2.27' \text{ downstream from base \&}$$

$$\text{Resultant location} = \frac{404.3}{46.19} - \frac{22.05}{3} = 1.40' \text{ inside kern OK}$$

$$p = \frac{46.19}{22.05} \left(1 \pm \frac{6 \times 2.27}{22.05} \right) \frac{1000}{144} = 15 \pm 9 = \begin{cases} 24 \text{ PSI @ Toe} & \text{OK} \\ 6 \text{ PSI @ Heel} & \text{OK} \end{cases}$$

$$\text{Sliding (f)} = \frac{28.08}{46.19} = .61 < .70 \text{ OK}$$

$$\text{Overturning } \left(\frac{M_R}{M_o} \right) = \frac{988.5}{584.2} = 1.69 > 1.5 \text{ OK}$$

MAIN

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 14 of 16
 Subject Lake Welch Dam Repairs By J.P. Palmer Date 3/31/78
Dam Stability Analysis Ckd. _____ Rev. _____

Case II D.L., Hydro, Seismic & Reinforcement Combined
 Extreme (Case II + Reinf)

	F_v	F_H	M_R	M_o
Case II	33.43 ^K	32.37 ^K	793.0 ^{IK}	672.1 ^{IK}
	<u>10.00</u>	<u>0.0</u>	<u>195.5</u>	<u>0.0</u>
	43.43	32.37	988.5	672.1

$$EM = 988.5 - 672.1 = 316.4^{IK} @ Toe$$

$$e = \frac{22.05}{2} = \frac{316.4}{43.43} = 3.74' \text{ downstream from base \&}$$

$$\text{Resultant location} = \frac{316.4}{43.43} - \frac{22.05}{3} = -.06' \text{ outside kern}$$

$$p = \frac{43.43}{22.05} \left(1 \pm \frac{6 \times 3.74}{22.05} \right) \frac{1000}{144} = 14 \pm 14 = \begin{cases} 28 \text{ PSI @ Toe} & c \\ -0 \text{ PSI @ Heel} & c \end{cases}$$

$$\text{Sliding (F)} = \frac{32.37}{43.43} = .75 \quad OK$$

$$\text{Overturning} \left(\frac{M_e}{M_o} \right) = \frac{988.5}{672.1} = 1.47 > 1.25 \quad OK.$$

(MAIN)

Client Palm Beach Interstate Park Commission Job No. 3308-1 Sheet 15 of 16

Subject Lake Wales Dam Repairs By R.D. Palmer Date 3/31/78

Dam Stability Analysis Ckd. _____ Rev. _____

Case VI (c) D.L., Hydro, Ice (3000#/l.f) & Reinf. Combined
Extreme (Case III (c) & Reinf.)

	F_v	F_H	M_R	M_o
Case <u>III</u> (c)	36.19	31.08	793.0	671.2
Reinf	<u>10.00</u>	<u>0.0</u>	<u>195.5</u>	<u>0.0</u>
	46.19	31.08	988.5	671.2

$$\Sigma M = 988.5 - 671.2 = 317.3'K @ Toe$$

$$e = \frac{22.05}{2} - \frac{317.3}{46.19} = 4.16'$$

$$\text{Resultant location} = \frac{317.3}{46.19} - \frac{22.05}{3} = -.48' \text{ outside kern}$$

$$p = \frac{46.19}{22.05} \left(1 \pm \frac{6 \times 4.16}{22.05} \right) \frac{1000}{144} = 15 \pm 16 = \begin{cases} 31 \text{ PSI @ Toe OK} \\ -1 \text{ PSI @ Heel OK} \end{cases}$$

$$\text{Sliding (f)} = \frac{31.08}{46.19} = .67 < .75 \text{ OK}$$

$$\text{Overturning } \left(\frac{M_R}{M_o} \right) = \frac{988.5}{671.2} = 1.47 > 1.25 \text{ OK}$$

†
d

MAIN

Client Palisades Interstate Park Commission Job No. 3308-1 Sheet 16 of 16
 Subject Lake Welch Dam Repair By R.D. Palmer Date 3/15/78
Dam Stability Analysis Ckd. _____ Rev. _____

	Dead Load	Hydrostatic	Earthquake	Ice (#/l.f.)	Toe Pressure (PSI)	Heel Pressure (PSI)	Sliding F_H/F_V	Overturning M_E/M_O	Resultant Location to D.S. Kern ①
Case I (normal)	✓	✓			27	- 5 ②	.78 ③	1.36 ③	- 1.58'
Case II (treme)	✓	✓	✓		32	- 10	.97 ③	1.18 ③	- 3.73'
Case III (a) (b) (c)	✓	✓		1000 2000 3000	30 32 35	- 8 - 10 - 13	.80 ③ .83 ③ .86 ③	1.29 1.23 ③ 1.18 ③	- 2.38' - 3.18' - 3.98'
Case IV (normal)	✓	✓			24	6	.61	1.69	1.40'
Case V (treme)	✓	✓	✓		28	- 0	.75	1.47	- .06'
Case VI (c) (treme)	✓	✓		3000	31	- 1	.67	1.47	- .48'

① Minus (-) Sign indicates tension.

② Minus (-) Sign indicates resultant outside kern.
 & tension at heel.

③ Does not meet criteria

MINUS SIGN

Palisades Interstate
Park Commission
Administration Building
Bear Mountain, NY 10911
914 786-2701

Nash Castro
General Manager



April 25, 1980

Mr. J. Patel
Tippetts-Abbett-McCarthy-Stratton
Engineers and Architects
The Tams Building
655 Third Avenue
New York, New York 10017

Dear Mr. Patel:

As requested, enclosed are the following documents:

1. Sheet 1 of consultant design agreement showing scope of services.
2. Correspondence from Chas. T. Main, Inc. dated October 5, 1977, March 31, 1978 and April 7, 1978.
3. Copies of diary sheets from October 9, 1978 to November 12, 1978.

Please call if you need any additional information.

Very truly yours,


Robert Santoro
Senior Park Engineer

RS:mgs
Encs:

RECEIVED
APR 29 1980
SOILS SECTION

REGION - Palisades

PROJECT NAME - Repairs to the Lake Welch Dam

P. F. NO. -

THIS AGREEMENT made this _____ day of _____, 19____, by and between the State of New York, acting by and through the Office of Parks and Recreation, hereinafter referred to as "PARKS", whose office is at Administration Building
Hear Mountain, New York 10911
and Chas. T. Main of N.Y. Inc. with offices at 125 E. 38th Street, New York,
New York 10016

hereinafter referred to as the "CONSULTANT."

WITNESSETH:

WHEREAS, PARKS is charged by the Law with the construction, maintenance and operation of state parks, parkways, historic sites, marine facilities and other recreational facilities and desires to obtain technical and professional services therein as hereinafter specified, and is authorized to engage such services in accordance with the provisions of the Parks and Recreation Law of the State of New York.

NOW, THEREFORE, in consideration of the premises and the mutual covenants and conditions contained herein the parties hereto agree as follows:

1. SCOPE OF SERVICES - PARKS agrees to employ and hereby does employ the CONSULTANT for the services hereinafter described, and the CONSULTANT agrees to furnish and perform such services upon the following described project:

Repairs to the Lake Welch Dam

The consultant will furnish services related to the repair of the Lake Welch Dam by means of chemical and cement grouting of horizontal construction joints and sealing of vertical expansion joints.

The method to be recommended by the consultant will enable the repair work to be carried out without the necessity of emptying the lake.

More specifically, the scope of the consultants' services shall consist of four parts, itemized as follows:

- Item 1 - Inspection of the dam, attendance at meetings, and other work required to propose a solution to the leakage problems, all performed prior to January 1, 1978.
- Item 2 - Performance and documentation of a stability analysis of the dam so as to determine the basic soundness and integrity of the dam.
- Item 3 - Under the assumption that the results of the analysis described in Item 2 show the dam to be essentially sound and capable of repair, the consultant will prepare drawings and specifications for the drilling, grouting and sealing of the dam. If the results of the work performed under Item 2 indicate that the dam is not sound or that some other means of repair are indicative, this agreement may be terminated or amended as appropriate to the conditions at this point.
- Item 4 - Field surveillance of the drilling, grouting and sealing work after the award of the construction contract by Parks.

The Consultant will furnish contract drawings in reproducible form after approval of preliminary drawings by Parks.

The Consultant will also furnish five (5) copies each of detailed contract

MAIN
Engineers

CHAS. T. MAIN OF NEW YORK, INC.

ONE, HALL & RICH DIVISION
125 EAST 38TH STREET, NEW YORK, NEW YORK 10016

5 October 1977

9010205-150

Mr. Robert Santoro
Palisades Interstate Park Commission
Administration Building
Bear Mountain, NY 10911

OCT 7 1977
ENGINEERING
P. I. E. C.

Dear Sir:

In compliance with your request we have undertaken a study of the leakage problem at Lake Welch Dam. The site was visited and we inspected the concrete cores obtained from the dam. We understand the need to reduce leakage through the dam and its foundation to a minimum and we appreciate the desirability of avoiding draining the lake. Considering both of these requirements, we offer the following solution:

1. Sealing of the horizontal construction joints of the dam, and the foundation of the dam and its abutments, by a combination of cement and chemical grouting.
2. Sealing of the vertical contraction joints by drilling a large (6") hole vertically through each joint and backfilling with a non-setting sealant.
3. The above procedures are to be performed in the early Spring of 1978 without the lake being drained.
4. Observation of the dam, foundation and sluice gate leakage through September 1978 when decisions can be made relative to:
 - a. Draining the lake to effect additional grouting or repairs, if indicated, to the upstream face of the dam.
 - b. The need for a new sluice gate, or the repair of the existing gate.
 - c. Refacing or repairing the downstream face of the dam for aesthetic reasons.
 - d. Performing other remedial work, also for aesthetic reasons.

It is our opinion that steps 1 and 2 above will successfully reduce leakage to a practicable minimum at the least cost. This solution has the further advantage of not requiring the draining of the lake during the recreation season. Should additional work

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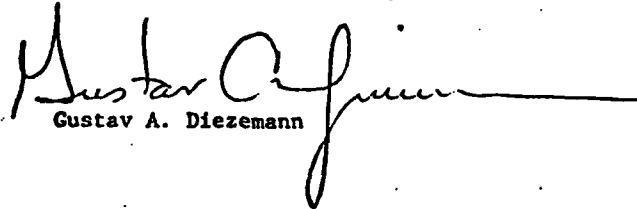
R. Santoro
5 October 1977
Page 2

requiring the draining of the lake be necessary, such can be performed early next Fall and the lake refilled before the 1979 season. We estimate the cost of steps 1 and 2 to be not in excess of \$225,000.

It is proposed that MAIN write the specification for the grouting program and provide a resident engineer for the surveillance of the field work. We estimate that the total cost of our services will not exceed \$30,000 up to and including steps 1 and 2. This figure is based on an estimate of 55 working days to perform steps 1 and 2.

We will be happy to discuss this subject with you and are available to meet with you at your convenience.

Yours very truly,
CHAS. T. MAIN OF NEW YORK, INC.


Gustav A. Diezemann

GAD:dc

cc: Mr. Thomas F. Connors
New York State Park & Recreation

FRIDAY, OCTOBER 14, 1977

<u>Name</u>	<u>Representing</u>
Ivan Vamoz	OPR Central office / Dept. Commis.
Dr. Peter J. R. Buttwer	" " / Dir Env. Mgt.
W. Roland Sauer	OGS - DFC / Envt.
JOHN J. TROY	PIPC
Bob Santoro	P.I.P.C.
Gus Diezemann	Chas. T. Main
CHARLES P. BENZIGER	" " "
MARTIN W. MOELLER	OGS - DFC.
John J. Schnorr	OGS - DFC
James E. Cassidy	OGS - DFC
THOMAS F. CONNORS	CPR - Development
THOMAS STODOLSKI	CPR - Development
NASH CASTRO	PALMARES INTERNATIONAL PART 1 & 2
Mark Hewitt	CPR

MAIN
Engineers

CHAS. T. MAIN OF NEW YORK, INC.

125 EAST 38TH STREET, NEW YORK, NEW YORK 10016

9T 4 RS

March 31, 1978

3308-001-1

Mr. Robert Santoro
Palisades Interstate Park Commission
Administration Building
Bear Mountain, New York 10911

RECEIVED

APR 7 1978

Dear Mr. Santoro:

ENGINEERING

Further to the draft of the report on our stability analysis of the Lake Welch Dam, we wish to advise you that post-tensioned rock bolts, five feet on centers and ten feet into rock, placed in reamed grout holes through the top of the dam would produce the following ratios of forces:

	Sliding	Overturning
Case I	1.64	1.69
Case II	1.33	1.47
Case III	1.49	1.47

The addition of the rock bolts improve the resistance to sliding and overturning significantly, as the above figures indicate. While there is nothing to assure that the dam would fail without the rock bolts, there is similarly no guarantee that the dam will never fail with the rock bolts installed. Considering the age and condition of the Lake Welch Dam, it is obviously prudent to install the bolts during the rehabilitation procedure. We estimate the cost of installation to be \$93,000.

Very truly yours,

CHAS. T. MAIN OF NEW YORK, INC.

Gustav A. Diczemann
Gustav A. Diczemann

CAD:vc

NEW YORK • LOWVILLE • MALONE • ORISKANY • POTSDAM • PRATTSVILLE

MAIN
Engineers

CHAS. T. MAIN OF NEW YORK, INC.

125 EAST 38TH STREET, NEW YORK, NEW YORK 10018

48.
9T/

April 7, 1978

3308-001-1

Mr. Robert Santoro
Palisades Interstate Park Commission
Administration Building
Bear Mountain, New York 10911

APR 10 1978

ENGINEERING
P. I. P. C.

Dear Mr. Santoro:

Reference is made to our letter of October 5, 1977 in which we stated that, if the recommended sealing of the Horizontal and vertical joints and the foundation of the Lake Welch Dam did not satisfactorily stop the leakage, the lake could be drained to effect additional grouting or repairs.

We also stated in that letter that we believed that the recommended sealing would reduce the leakage to a practicable minimum. We are still of that opinion. We cannot, however, for obvious reasons, guarantee that it will.

Should additional repairs be necessary, and we repeat that we believe the recommended will be successful, it is not possible to estimate the cost of such repairs until the problem, if any, is known.

Very truly yours,

CHAS. T. MAIN OF NEW YORK, INC.

Gustav A. Diezemann
Gustav A. Diezemann
Vice President

CAD:vc

NEW YORK • LOWVILLE • MALONE • ORISKANY • POTSDAM • PRATTSVILLE

Sunday

stripping Shale to
in morning 4 men in water
dressed 1/2 23 ft.

Started grafting about 9.10 a.m.
then 7-8 gal's water 1 cement
2 sand, kept Browne's horse
cut sand down to 1 shovel.

per man, GRAFTED
SECTION 1, 2, 3, 2 Holes
on section 4 GRAFT NEAR

CAME OUT OF LIFT SEAMS
TOOK PRESSURE UP to 65 lbs
Holes holding pressure,

GRAFTED SECTION & 2 SEAMS 13 ft
2 3 ft

64 C. FT

All holes are filled from
bottom up

1/2

OCTOBER 10

Clear Warm

Started Geomys 12-0. Started Chipping 8-00. A man
 Geomys has 4/3 Great Cone described to take all of spilling
 up 4/4. Lowered Darts in 4/3 Shotcrete and make each section
 to 12 ft. Then put Darts One Shot. don't take a patch
 in 4/4. Geomys 50 lbs. for spilling on account of
 15 min then 35/6 for 15 min. inverter going in cracks
 re. geant came out of left joint if any appear
 water. I lowered down in 12 holes
 about 12 to 15 ft.

Geomys 5/11 25/11 the 45 lbs. shot no patches, had to make one
 Started Chipping 4 men again.

Lost bucket in hole or 5/2 reaming out goant holes
 broke pipe off when trying told him to break holes out
 to Jack out. will have to after cone (don't do)
 drill hole along side of it.

all Holes are filled from bottom
 up
 Geomys in 2 stages 13 ft 3 ft

Bl

all holes are filled from bottom
 up geomys took 12 ft down
 and from 5 ft down
 for Geomys. 2 Cited Dispersed.

OCTOBER 11

Clear Warm

Started Chipping 8-00. A man
 described to take all of spilling
 up 4/4. Lowered Darts in 4/3 Shotcrete and make each section
 to 12 ft. Then put Darts One Shot. don't take a patch
 in 4/4. Geomys 50 lbs. for spilling on account of
 15 min then 35/6 for 15 min. inverter going in cracks
 re. geant came out of left joint if any appear
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 drill hole along side of it.

all Holes are filled from bottom
 up
 Geomys in 2 stages 13 ft 3 ft

Bl

all holes are filled from bottom
 up geomys took 12 ft down
 and from 5 ft down
 for Geomys. 2 Cited Dispersed.

OCTOBER 16

OCTOBER 17

Cement Cured in Holes in Wall (W.H.M. in H.T.)

Cement Cured

Grouted 11/1 11/2 11/3

STARTED CHIPPING

12/1 12/2 12/3

REPAIRING OUT GROUTED HOLES ALSO

WASHING THEN OUT

Grout Filler 11/2 Cured in 11/3)
USED DOUBLE PACKEDIN 2 HOLES USED 26 Cu. Ft. of
Grout (Cement 70, 1 Cement chipped)

1. 1 gal. then 6 then 1

Solid for 5 min a solid no
more grout takenExtracting 5/2 5/3 the remaining
grout holes to bottom washing
them out now as they are completed

G.H.

extraction where other equipment
is used it was covering hole
from No. 10 hole in holes until
cotton 12/1 no in 2 grout
shut was here

12/1 12/2 12/3

4 Cu. Ft. to

Fill in holes from

12/1 12/2 12/3

Q.1

OCTOBER 18

Line Cited

Started shipping spooling
3 men

Reaming ground out of holes

OCTOBER 19

Line Cited

Started shipping spooling
8 men

3 men

Brought plat form back
to section 6

Let them drill some of
the chemical grout holes
far enough apart so that
there is no pressure on
between holes. Told him
he could do it and he
would be responsible for
the holes he said okay

of

7/1 Chem 23

6/1 " 23

6/3 " 23

6/6 " 23

6/8 " 23

5/6 " 22

5/3 " 22

5/1 " 22

OCTOBER 20

Miss Condit

10:30

Started chipping splintery
also No 2 section catching up

Walled New Grant hole

$$\frac{3}{16}$$

16

$$\frac{3}{4}$$

16

$$\frac{2}{1}$$

16

$$\frac{2}{16}$$

14

$$\frac{2}{5}$$

14

$$\frac{2}{13}$$

14

$$\frac{2}{11}$$

14

$$\frac{1}{5}$$

13

$$\frac{1}{4}$$

12

$$\frac{1}{3}$$

12

$$\frac{1}{22}$$

12

$$\frac{1}{11}$$

12

166 of material

$$\frac{18}{166}$$

3 1/2 -

OCTOBER 20

Miss Condit

Started chipping joints
of splintery

Conductor asked if he could
build a road down from Denver
side of lake so he could build
his float road along on long
as he fires up the grounds
as before, filled in along side
of waterbed part of dam,

9 hrs

236

OCTOBER 24

wire beam

Drilling 12" holes 4 done
 large pieces of rock in Corvato
 some boulders very hard drilling
 around 2 hrs per hole section
 1 complete

Building float for drill,
 coil of 25 gal Oil drums
 dry them & well hold weight
 of drill

Ghas

297

OCTOBER 25

wire beam

Drilling 12" holes, hard drill
 very slow section 2 complete
 started on section 3

trouble with union straightness of wire

Ghas

OCTOBER 24 '33

OCTOBER 25 '34

Building float

Clear Cold morning

Building float for drill rig completed. Float and put rig on it. 4.30 did not hold weight of drill had to unload. Chipping 12" holes out. Called Chuck Benzinger, told him 12" holes but very hard drilling and I would let them drill a series of 20 3/4 inch holes around template to make it easier on diamond bit and it cuts faster, works ok so far. The holes are 6 to 7" in deep.

Completor beds 3, part beds of contractor came to look at dim for boxy coat & sand blast. He said he needed at least 5 or 7 days of 70 degrees to cure epoxy.

Chipping finished well not well to hard. We will not compare done in year.

Chipping Spilling & running 2 floats. Building float had to get extra oil to tanks. (500 gal.) 2.75 in.

Diamond drilling holes complete section 4 & 5.

3:30

OCTOBER 25

OCTOBER 27

301

Shipping up the morning of 1

Shipping up the morning of 1

Shipping up the morning of 1

Drilling large holes drilling

small holes ahead seems to

help, completed section 6 started

section 7, loaded drill on

float about 1 ft out of

water, started making bottom

of large diameter, level

ready for rock bolts

noted bottom of rock bolts

are 20 cm to 2 Expander 8 in

Oct 26th Rain ✓

Started shipping 3 Crows

Drilling ground out of section 11

2.12 then drilling 12" holes

Rain all day.

11/1

11/2

11/3

12/1

12/2

Started on section 13 Port Hill

13/1 32 29 44 ✓ 17/1 37

13/2 34 29 44 ✓ 15/1 37

14/1 34 29 44 ✓ 15/2 37

14/2 32 43 ✓ 15/3 37

Started to pup rock anchors in

on section 5 1 2 - 3

put 600 lb tension on guys

put hydraulic jack pump on

anchor bolts, hydraulic

not register

11/1

11/2

252 ft

2

Starts Kipping A-circus.

23

12/3	20 r 10	30	28	17/3	7	10
------	---------	----	----	------	---	----

[illegible]

1

Final Nov 5, 1967

met 6:30/ps on 11.3.1944
met 5.12.44 at hotel Bristol

sp. coming up, on 10.18.44

1 N.3 1/2 hole drive cone & wire

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

2	30	1st conty.
3	30	1st conty.

Williamo Bolt Plan Come, derms

1890

306

NOVEMBER 1

11 SEASONS DAY

Lilac Malt

Started chipping

NOVEMBER 2

28

307

Gravelled Lilac Malt

Chipping Spillway. Acres

Gravelled SECTION 13, 14, 15, 16,

17, 18, 19, 31 ft. Gravelled River Beds

6/2 31 ft. 1/2 3/1 4/1

6/3 32 ft. 1/3 3/2 4/2

7/1 32 ft. 2/1 4/3

7/2 33 ft. 2/2 4/4

7/3 33 ft. 2/3 5/2

8/1 34 ft. 5/3

6/1

CHIM GRANT HOUSE DRIVES

19/1 8 18/1 10 17/1 18

19/2 8 18/2 9 17/2 19

19/3 8 18/3 9 3 1

19/4 8 18/4 9 4 1

19/5 8 18/5 8 5 11

19/6 8 18/6 8 6 6

19/7 8 18/7 8 7 15

45 19

Electric Machine broke down.
Left to deliver 12 in 13: Helms

NOVEMBER 3

*Clear**Drilling: 3 levels**Clear Warm
Drilling 12" Holes Completed*

NOVEMBER 4

Sealed Bottoms

7/2	33 ft.	Torqued to 600 lb. 28
8/3	32 ft.	4 28
9/1	34 ft.	4 28 tons
9/2	36 ft.	11 28 tons
9/3	36 ft.	4 28 tons

44
176
220
260

13/24 ✓ 30 ft. ✓
13/24 ✓ 34 ft. ✓

14/1 ✓ 30 ft. (torqued) 14/6 ✓ 32
14/24 ✓ 30 ft. 14/7 ✓ 32
14/5 ✓ 34 ft. 14/8 ✓ 32
14/9 ✓ 30

15/1 30 ft.
15/2 28 ft.
15/3 28 ft.

New Electric Machine arrived.

2.1

310

NOVEMBER 5

311

NOVEMBER 6

Clear beam

Shipping 4 Crews

Bleeding 12 Holes out
washing threads ready for
Plastic Grease

Grouted up to 9/3

Installed Rock Bolts

10/1 34 ft

10/2 32 ft

10/3 31 ft

11/1 31 ft

11/2 32 ft

11/3 32 ft

12/1 31 ft

Back the bleeding detail 8 ft
alongside dam,

Drilling Grouted Holes
out ready for Rock Bolts

13 bolts 40 ft 14 ft 15 ft 16 ft

17 ft 18 ft

NOVEMBER 7

Chipping 2 crews
 9 hrs Chipping
 1 Dynamite 2 men
 1 new clearing 12 holes
 600 lbs dynamite
 10/1 11/1 12/1 Raining
 10/2 11/2
 11/3 11/3
 all 28 tons
 10/1 2, 3 11/1 2, 3
 GREATER BOTTOM 12/1

Drilled Chem Holes

8/8 26 ft
 8/2 26 ft
 8/6 26 ft
 8/5 20 ft
 8/4 26 ft
 8/3 26 ft
 8/2 26 ft
 8/1 26 ft

66

NOVEMBER 8

Chipping 2 crews
 9 hrs Chipping
 1 Dynamite 2 men
 1 new clearing 12 holes
 600 lbs dynamite
 10/1 11/1 12/1 Raining
 10/2 11/2
 11/3 11/3
 all 28 tons
 10/1 2, 3 11/1 2, 3
 GREATER BOTTOM 12/1

8/8 26 ft
 8/2 26 ft
 8/6 26 ft
 8/5 20 ft
 8/4 26 ft
 8/3 26 ft
 8/2 26 ft
 8/1 26 ft

66

NOVEMBER 8

Clear Milled

Clear Milled

Clearing up site

chipping some of edges off rough cuts.

Drilling Lichen Holes

chilling Lichen Grass holes

10/1 26' 9/8 20

10/3 24' 9/7 20

10/6 24' 9/5 20

10/8 24' 9/4 28

11/1 24' 9/2 27

11/4 24' 9/1 26

11/6 24' 9/8 16.5

11/9 24' 9/6 98

11/11 24' 9/5 96

11/13 24' 9/4 165

11/15 24' 9/3 359

11/17 24' 9/2 16.5

11/19 24' 9/1 16.5

11/21 24' 9/8 16.5

11/23 24' 9/7 16.5

11/25 24' 9/5 16.5

11/27 24' 9/4 16.5

11/29 24' 9/3 16.5

11/31 24' 9/2 16.5

12/3 24' 9/1 16.5

12/5 24' 9/8 16.5

12/7 24' 9/7 16.5

12/9 24' 9/5 16.5

12/11 24' 9/4 16.5

12/13 24' 9/3 16.5

12/15 24' 9/2 16.5

12/17 24' 9/1 16.5

12/19 24' 9/8 16.5

12/21 24' 9/7 16.5

12/23 24' 9/5 16.5

12/25 24' 9/4 16.5

17/1 15

14/1 30

15/8 76

15/11 30

15/4 30

C/

316

NOVEMBER 11

Veterans' Day

Thurs

Celine Coley
Dorrelling Dr Stokes

6 Stokes Dr

OK

317

NOVEMBER 12

Mo work

Friday

REFERENCES

APPENDIX G

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